ANL-5334

ARGONNE NATIONAL LABORATORY
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Lemont, Illinois

ESTIMATION OF FISSION PRODUCT SPECTRA IN FUEL ELEMENTS DISCHARGED FROM THE POWER BREEDER REACTOR AND THE EXPERIMENTAL BREEDER REACTOR NO. 2

by

I. G. Dillon and Leslie Burris, Jr.

CHEMICAL ENGINEERING DIVISION

October 1954

Operated by The University of Chicago
under
Contract W-31-109-eng-38

UNCLASSIFIED

ANL-5334

Subject Category: PHYSICS

UNITED STATES ATOMIC ENERGY COMMISSION

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Date Declassified: September 23, 1955.

Printed in USA, Price 30 cents. Available from the Office of Technical Services, Department of Commerce, Washington 25, D. C.

AEC, Oak Ridge, Tenn.

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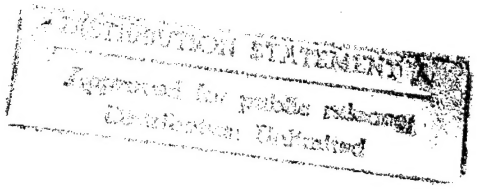

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Information on the fission product spectrum (both active and inactive fission products) in discharged fuel is necessary in the study of pyrometallurgical processing of fuel elements. Two types of fuel of interest are the plutonium-uranium alloy (10 per cent plutonium by weight) of the fast power breeder reactor and the 10 per cent plutonium-239, 20 per cent uranium-235, 70 per cent natural uranium fuel for the EBR-II reactor, the pilot reactor for the fast power breeder reactor.

The basic data necessary for these calculations are the fission yield data as a function of mass number. Data were available from which the fast fission product spectra of plutonium fissioned with 2 Mev neutrons and of uranium-235 fissioned with 1 Mev neutrons could be estimated. Neither of these neutron energies duplicate conditions in the above two fast reactors in which the average fast neutron energy is estimated to be about 100 kev, but the data were considered sufficiently accurate for this purpose. Furthermore, the errors are not likely to be great and are conservative; that is, the calculated yield of such elements as ruthenium, rhodium, and palladium which are difficult to remove by slagging will probably be slightly higher than actually found in the fuel from these reactors.

For the PBR (Power Breeder Reactor) calculations, the fuel element was assumed to be in the pile for 135 days (in accordance with preliminary specifications) with fissions occurring at such a uniform rate that 2 per cent of the total fuel element atoms would have fissioned at the time of discharge. The same bases were used for EBR-II fuel elements. Also, to show the effect of pile irradiation time, cases were calculated for 85 days pile irradiation and 15 days cooling for both PBR and EBR-II reactors. For this range, the changes in fission product spectra were small.

One of the assumptions required for these calculations was that of the distribution of nuclear charge in fission for a given mass number. The data of L. E. Glendenin et al., were used,[1] and private communications were held with L. E. Glendenin. It was indicated that the predominant distribution of nuclear charge arising directly in fission is about three beta decays

[1] L. E. Glendenin; Coryell, D. C.; and Edwards, R. R.; "Distribution of Nuclear Charge in Fission," Paper 52, Div. IV Volume 9, National Energy Series, 489 (1951).

removed from a stable isotope or an isotope with a half-life measured in hours. Most of these isotopes formed directly in fission either have half-lives so short that they may be neglected or so short that they have never been measured. Therefore, one hundred per cent formation was assumed for the first isotope of reasonably long half-life along a decay chain. Generally, isotopes with half-lives less than 1 day were not considered.

A constant rate of isotope formation in the reactor was assumed and the decay of a particular isotope and formation of its daughters during irradiation in the reactor was calculated.[2] Any neutron absorption by fission products in the reactor was neglected.

For many of these calculations, 100 gram-atoms of material (uranium-235, plutonium-239, or both) were assumed to have fissioned. To calculate the total grams of an element present, an average atomic weight was calculated on the basis of the distribution of its isotopes.

The fission yield data for plutonium-239 fissioned by 2 Mev neutrons is given in Table I and plotted in Figure 1. Similarly, the fission yield data for uranium-235 fissioned by 1 Mev neutrons is shown in Table II and plotted in Figure 2.

Fission Product Spectra in Discharged PBR Fuel Elements

The results of various calculations are shown in Tables III through VIII as follows:

Table III shows the individual isotopic fission product spectrum for fast fission of plutonium in fuel elements irradiated 135 days and cooled varying times after discharge (from 0 to infinite days).

Table IV is extracted from Table III and shows the distribution for elements rather than isotopes as a function of cooling time. It will be noted that elements which predominate in amount are zirconium, molybdenum, ruthenium, palladium, xenon, cesium, cerium, and neodymium.

Table V shows the calculated composition of discharged PBR fuel after 15 days cooling.[3]

Table VI shows the individual isotopic fission product spectrum for fast fission of plutonium in fuel elements irradiated 85 days and cooled varying times after discharge (from 0 to infinite days).

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[2]All calculations performed by I. G. Dillon.

[3]Neglecting fast fission of uranium-238.

Table VII is extracted from Table VI and shows the distribution for elements rather than isotopes as a function of cooling time. The same elements predominate as in Table IV.

Table VIII shows the calculated composition of discharged PBR fuel after 15 days cooling (85 days irradiation).[3]

Fission Product Spectra in Discharged EBR-II Fuel Elements

Since EBR-II fuel contains both plutonium-239 and uranium-235, data corresponding to those in Tables III and IV above were compiled for uranium-235 irradiated 135 days and are presented in Tables IX and X. In Table XI there is given the calculated composition of discharged EBR-II fuel.

Data for uranium-235 irradiated 85 days are given in Tables XII and XIII. Table XIV was compiled from these tables and from Tables VI and VII to give the calculated composition of a discharged EBR-II fuel irradiated 85 days and cooled 15 days.

A comparison of the fission product spectrum for PBR discharged fuel and EBR-II discharged fuel (both irradiated 135 days and cooled 15 days) may be readily made by means of the bar graphs of Figures 3 and 4.

Appendix

In calculating the isotopic distribution of fission products from irradiation of fissionable materials, the following variables must be considered:

(a) time of pile irradiation,
(b) relative fission yield of each isotope along the decay chain of the particular mass number in question,
(c) time of cooling after discharge from the pile,
(d) half-lives of the isotopes along a decay chain.

The use of these variables is illustrated in the following examples and derivations.

Calculation of the Relative Amounts of the Isotopes Present at Any Time in the Reactor

In the fast fission (ca. 2 Mev) of plutonium-239 the yield at mass number 95 is 5.27 atoms per 100 atoms plutonium-239 fissioned. The decay chain for mass number 95 is as follows:

$$Y^{95} \xrightarrow[\beta^-]{10m} Zr^{95} \xrightarrow[\beta^-]{65d} Nb^{95} \xrightarrow[\beta^-]{35d} Mo^{95} \quad \text{Stable}$$

which may be represented symbolically as:

$$A \longrightarrow B \longrightarrow C \longrightarrow D$$

The decay constants are:

$$A = \frac{0.693 \times 60 \times 24}{10 \text{ m}} = 100 \text{ days}^{-1}$$

$$B = \frac{0.693}{65} = 0.01065 \text{ days}^{-1}$$

$$C = \frac{0.693}{35} = 0.01980 \text{ days}^{-1}$$

For these isotopes, the relative fission yield may be calculated by a method outlined by L. E. Glendenin.[1] In a table of this paper the most probable charge of the primary fission fragment, Z_P, is given as 38.1 for mass 95. The relative fission yield along a chain may be obtained from a plot of $Z-Z_P$ versus relative fission yield, where Z is the nuclear charge of the isotope. While these data are for thermal fission, it is believed that they hold fairly well for fast fission. For mass 95, the relative fission yields are as follows:

	$Z-Z_P$	Relative Fission Yield
Y	0.9	0.28
Zr	1.9	0.03
Nb	2.9	negl.
Mo	3.9	negl.

This means that of the fission yield of 5.27 atoms/100 atoms fissioned, 28 per cent is Y^{95}, 3 per cent is Zr^{95}, and the remaining 69 per cent is in unmeasured shorter lived isotopes. Actually, the yield of Y^{95} may be considered to be 97 per cent of the chain yield because of the nearly instantaneous decay of the shorter-lived isotopes. (Because of the short half-life of Y^{95}, the yield of Zr^{95} may be considered to be 100 per cent of the chain yield for all practical purposes.)

The rate of change of isotope A is:

$$\frac{dA}{dt} = R_A - \lambda_A A \qquad (1)$$

where

A = atoms of isotope A

R_A = rate of production of A by fission in atoms per day

λ_A = decay constant for A in days^{-1}

The solution of this equation for the amount of A present at any time is:

$$A = \frac{R_A}{\lambda_A} (1 - e^{-\lambda_A t}) \tag{2}$$

the rate of formation of isotope B is:

$$\frac{dB}{dt} = R_B - \lambda_B B + \lambda_A A \tag{3}$$

where A is as in equation (2). On substitution of A, this becomes:

$$\frac{dB}{dt} = R_B - \lambda_B B + R_A (1 - e^{-\lambda_A t})$$

$$\frac{dB}{dt} + \lambda_B B = R_B + R_A (1 - e^{-\lambda_A t}) \tag{4}$$

The solution of this equation for the amount of B present at any time is:

$$B = \frac{R_A + R_B}{\lambda_B} (1 - e^{-\lambda_B t}) - \frac{R_A}{\lambda_B - \lambda_A} (e^{-\lambda_A t} - e^{-\lambda_B t}) \tag{5}$$

The rate of formation of element C with no yield from fission is:

$$\frac{dC}{dt} = \lambda_B B - \lambda_C C \tag{6}$$

$$\frac{dC}{dt} + \lambda_C C = \lambda_B B - (R_A + R_B) (1 - e^{-\lambda_B t}) - \frac{\lambda_B R_A}{\lambda_B - \lambda_A} (e^{-\lambda_A t} - e^{-\lambda_B t}) \tag{7}$$

The solution of this equation is:

$$C = \frac{R_A + R_B}{\lambda_C} (1 - e^{-\lambda_C t}) + \frac{e^{-\lambda_B t} - e^{-\lambda_C t}}{\lambda_C - \lambda_B} \left[\frac{R_A \lambda_A - R_B (\lambda_B - \lambda_A)}{\lambda_B - \lambda_A} \right] -$$

$$\frac{\lambda_B R_A (e^{-\lambda_A t} - e^{-\lambda_C t})}{(\lambda_B - \lambda_A) (\lambda_C - \lambda_A)} \tag{8}$$

The rate of formation of stable element D is:

$$\frac{dD}{dt} = \lambda_C C \tag{9}$$

Substituting (8) in (9)

$$\frac{dD}{dt} = (R_A + R_B)(1 - e^{-\lambda_C t}) + \lambda_C \frac{(e^{-\lambda_B t} - e^{-\lambda_C t})}{\lambda_C - \lambda_B} \left[\frac{\lambda_A R_A - R_B(\lambda_B - \lambda_A)}{\lambda_B - \lambda_A}\right] - \frac{\lambda_B \lambda_C R_A (e^{-\lambda_A t} - e^{-\lambda_C t})}{(\lambda_B - \lambda_A)(\lambda_C - \lambda_A)} \tag{10}$$

The amount of D present at any time "t" is therefore

$$D = (R_A + R_B)\left(t + \frac{e^{-\lambda_C t} - 1}{\lambda_C}\right) + \frac{\lambda_C \lambda_A R_A - \lambda_C R_B (\lambda_B - \lambda_A)}{(\lambda_C - \lambda_B)(\lambda_C - \lambda_A)} \left[\frac{1 - e^{-\lambda_B t}}{\lambda_B} - \frac{1 - e^{-\lambda_C t}}{\lambda_C}\right] - \frac{\lambda_B \lambda_C R_A}{(\lambda_B - \lambda_A)(\lambda_C - \lambda_A)} \left[\frac{1 - e^{-\lambda_A t}}{\lambda_A} - \frac{1 - e^{-\lambda_C t}}{\lambda_C}\right] \tag{11}$$

The following is obtained on substituting values in these equations to give the relative amounts present after 85 days' irradiation.

$$R_A = \frac{\text{Yield Fraction of A}}{\text{Irradiation Time}} = \frac{5.12}{85} = 0.0602 \frac{\text{atoms}}{\text{day}}$$

$$\frac{R_A}{\lambda_A} = \frac{5.12}{(85)(100)} = 0.000602$$

$$e^{-\lambda_A t} = e^{-8500} \cong 0$$

$$A = \frac{R_A}{\lambda_A}(1 - e^{-\lambda_A t}) = \underline{\underline{0.0006}} \text{ atoms/100 atoms } Pu^{239} \text{ fissioned}$$

$$R_B = \frac{0.15}{85} = 0.001765$$

$$\frac{R_B}{\lambda_B} = \frac{0.15}{(85)(0.01065)} = 0.1659$$

$$\frac{R_A + R_B}{\lambda_B} = \frac{0.0618}{0.01065} = 5.8$$

$$e^{-\lambda_B t} = e^{-0.905} = 0.405$$

$$B = 5.8\,(1 - 0.405) - \frac{0.0602}{-100}\,(0 - 0.405) = \underline{\underline{3.455}}$$

$$C = \frac{0.0618}{0.0192}\,(1 - e^{-1.63}) + \frac{0.405 - 0.195}{0.00855}\left[\frac{(0.0602)(100) + (0.1765)}{-100}\right]$$

$$- \frac{(0.01065)(0.0602)(0 - e^{-1.63})}{(-100)(-100)} = \underline{\underline{1.015}}$$

$$D = 0.0618\left(85 + \frac{0.195 - 1}{0.0192}\right)$$

$$+ \frac{(0.0192)(100)(0.0602) - (0.0192)(0.001765)(-100)}{(0.00855)(-100)}$$

$$\left[\frac{0.595}{0.01065} - \frac{0.805}{0.0192}\right]$$

$$- \frac{(0.01065)(0.0192)(0.0602)}{(-100)(-100)}\left[\frac{1}{100} - \frac{0.805}{0.0192}\right] = \underline{\underline{0.730}}$$

D could have been obtained by subtracting from 5.27 the amounts of A, B, and C present.

Since $\lambda_A t > 10\, e^{-\lambda A t} \cong 0$, this calculation can be simplified by assuming 100% yield for B and negligible A present at any time. Then $B \rightarrow C \rightarrow D$ is the decay scheme and the equation becomes:

$$\frac{dB}{dt} = R_B - \lambda_B B$$

$$B = \frac{R_B}{\lambda_B}\,(1 - e^{-\lambda_B t})$$

$$\frac{dC}{dt} = \lambda_B B - \lambda_C C$$

$$\frac{dC}{Ct} = \lambda_C C = R_B\left[\frac{e^{(\lambda_C - \lambda_B)\,t} - 1}{\lambda_C - \lambda_B}\right]$$

$$C = \frac{R_B}{\lambda_C}(1 - e^{-\lambda_C t}) - R_B \frac{(e^{-\lambda_B t} - e^{-\lambda_C t})}{\lambda_C - \lambda_B}$$

$$\frac{dD}{dt} = \lambda_C C - R_B (1 - e^{\lambda_C t}) - \frac{R_B \lambda_C (e^{-\lambda_B t} - e^{-\lambda_C t})}{\lambda_C - \lambda_B}$$

The solution of which is:

$$D = R_B \left(t - \frac{1 - e^{-\lambda_C t}}{\lambda_C}\right) - \frac{\lambda_C R_B}{\lambda_C - \lambda_B} \left[\frac{(1 - e^{-\lambda_B t})}{\lambda_B} - \frac{(1 - e^{-\lambda_C t})}{\lambda_C}\right]$$

$$R_B = \frac{5.27}{85} = 0.0618$$

$$B = \frac{0.0618}{0.01065}(1 - 0.405) = 3.455$$

$$C = \frac{0.0618}{0.0192}(1 - 0.195) - \frac{0.0618\,(0.405 - 0.195)}{0.00855} = 1.085$$

$$D = 0.0618 \left(85 - \frac{0.805}{0.0192}\right) - \frac{(0.0192)(0.0618)}{0.00855} \left[\frac{0.595}{0.0165} - \frac{0.805}{0.0192}\right] = 0.730$$

Cooling After Discharge from the Reactor

For cooling out of the reactor, straightforward decay equations are employed. Generally, the second decay was to a stable or very long-lived isotope, so that the only equations needed were:

$$\frac{dA}{dt} = \lambda_A A \text{ giving } A = A_0 e^{-\lambda t}$$

and

$$\frac{dB}{dt} = \lambda_A A - \lambda_B B \text{ giving}$$

$$B = \frac{\lambda_A A_0}{\lambda_B - \lambda_A} e^{-\lambda_A t} + \left(B_0 - \frac{\lambda_A A_0}{\lambda_B - \lambda_A}\right) e^{-\lambda_B t}$$

where A_0 and B_0 are the amounts of A and B present at the time of discharge. The amount of C present (if C were stable or very long-lived) may be obtained by difference, or may be calculated by the expression:

$$C = \frac{A_0 \lambda_B}{\lambda_B - \lambda_A}(1 - e^{-\lambda_A t}) + \left(B_0 - \frac{A_0 \lambda_A}{\lambda_B - \lambda_A}\right)(1 - e^{-\lambda_B t}) + C_0$$

TABLE I

Yields From Fast Fission of Pu^{239} (ca. 2 Mev Neutrons)

(Atoms per 100 atoms Pu^{239} fissioned)

Mass No.	Yield	Mass No.	Yield	Mass No.	Yield
82	0.008	107	4.800	132	6.380
83	0.098	108	3.300	133	6.250
84	0.200	109	1.700	134	6.300
85	0.330	110	0.840	135	6.220
86	0.530	111	0.490	136	6.000
87	0.810	112	0.185	137	5.800
88	1.270	113	0.170	138	5.600
89	1.840	114	0.127	139	5.300
90	2.300	115	0.094	140	5.000
91	2.770	116	0.008	141	4.700
92	3.300	117	0.007	142	4.400
93	3.750	118	0.007	143	4.900
94	4.200	119	0.007	144	3.700
95	5.270	120	0.008	145	3.250
96	5.100	121	0.009	146	2.900
97	5.200	122	0.011	147	2.550
98	5.600	123	0.128	148	2.200
99	5.900	124	0.180	149	1.900
100	6.000	125	0.260	150	1.580
101	6.200	126	0.400	151	1.300
102	6.350	127	0.620	152	0.900
103	6.430	128	1.100	153	0.480
104	6.600	129	1.800	154	0.300
105	4.820	130	3.000	155	0.180
106	6.350	131	4.900	156	0.080
				157	0.020
					Σ = 203.567

Σ 83 to 118 = 102.954

Σ 119 to 157 = 100.613

203.567

TABLE II

Yields From Fast Fission U^{235} (ca. 1 Mev Neutrons)

(Atoms per 100 Atoms U^{235} Fissioned)

Mass No.	Yield	Mass No.	Yield	Mass No.	Yield
77	0.009	104	2.775	131	3.110
78	0.020	105	1.026	132	4.450
79	0.042	106	0.470	133	6.620
80	0.075	107	0.280	134	7.810
81	0.133	108	0.163	135	6.560
82	0.250	109	0.087	136	6.420
83	0.382	110	0.079	137	6.190
84	0.625	111	0.067	138	6.120
85	1.142	112	0.042	139	6.250
86	1.644	113	0.043	140	5.800
87	2.890	114	0.044	141	5.300
88	3.500	115	0.045	142	5.190
89	4.185	116	0.045	143	5.190
90	4.420	117	0.048	144	4.770
91	5.310	118	0.048	145	4.320
92	5.300	119	0.052	146	3.870
93	5.425	120	0.052	147	3.240
94	5.700	121	0.055	148	2.280
95	6.770	122	0.053	149	1.185
96	6.750	123	0.053	150	0.735
97	6.560	124	0.080	151	0.465
98	6.240	125	0.123	152	0.282
99	6.200	126	0.180	153	0.142
100	6.750	127	0.260	154	0.067
101	6.050	128	0.430	155	0.029
102	5.300	129	0.790	156	0.013
103	4.000	130	1.525	157	0.007
					Σ = 201.002

Σ 77 to 116 = 100.838

Σ 117 to 157 = 100.164

201.002

TABLE III

Fission Product Spectrum For Fast Fission (ca. 2 Mev Neutrons) of Pu^{239} (135 Days Irradiated)

Element	Mass No.	Half Life	Atoms/100 Atoms Pu^{239} Fissioned after Cooling: 0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Se	82	Stable	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Kr	83	Stable	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098
	84	Stable	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
	85	9.4y	0.330	0.330	0.328	0.326	0.323	0.310	0.306	0.281	0.158	0.000
	86	Stable	0.530	0.530	0.530	0.530	0.530	0.530	0.530	0.530	0.530	0.530
			1.158	1.158	1.156	1.154	1.151	1.138	1.134	1.109	0.986	0.828
Rb	85	Stable	---	---	0.002	0.004	0.007	0.020	0.024	0.049	0.172	0.330
	87	6.2×10^{10}y	0.810	0.810	0.810	0.810	0.810	0.810	0.810	0.810	0.810	---
			0.810	0.810	0.812	0.814	0.817	0.830	0.834	0.859	0.982	0.330
Sr	87	Stable	---	---	---	---	---	---	---	---	---	0.810
	88	Stable	1.270	1.270	1.270	1.270	1.270	1.270	1.270	1.270	1.270	1.270
	89	54d	0.860	0.708	0.581	0.391	0.232	0.007	0	0	0	0
	90	19.9y	2.290	2.280	2.270	2.270	2.260	2.220	2.210	2.130	1.620	0
			4.420	4.258	4.121	3.931	3.762	3.497	3.480	3.400	2.890	2.080
Y	89	Stable	0.980	1.132	1.259	1.449	1.608	1.833	1.840	1.840	1.840	1.840
	91	61d	1.415	1.190	1.000	0.710	0.450	0.040	0.020	0.000	0	0
			2.395	2.322	2.259	2.159	2.058	1.873	1.860	1.840	1.840	1.840
Zr	90	Stable	0.010	0.020	0.030	0.030	0.040	0.080	0.090	0.170	0.680	2.300
	91	Stable	1.355	1.580	1.770	2.060	2.320	2.730	2.750	2.770	2.770	2.770
	92	Stable	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300
	93	9.5×10^{5}y	3.750	3.750	3.750	3.750	3.750	3.750	3.750	3.750	3.750	0
	94	Stable	4.200	4.200	4.200	4.200	4.200	4.200	4.200	4.200	4.200	4.200
	95	65d	2.800	2.390	2.030	1.480	0.970	0.110	0.060	0.000	0	0
	96	Stable	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100
			20.515	20.340	20.180	19.920	19.680	19.270	19.250	19.290	19.800	17.670
Nb	93	Stable	---	---	---	---	---	---	---	---	---	3.750
	95	35d	1.145	1.216	1.219	1.103	0.860	0.135	0.067	0.002	0	0
Mo	95	Stable	1.325	1.664	2.021	2.687	3.440	5.025	5.143	5.268	5.270	5.270
	97	Stable	5.200	5.200	5.200	5.200	5.200	5.200	5.200	5.200	5.200	5.200
	98	Stable	5.600	5.600	5.600	5.600	5.600	5.600	5.600	5.600	5.600	5.600
	99	67h	0.180	---	---	---	---	---	---	---	---	---
	100	Stable	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
			18.305	18.464	18.821	19.487	20.240	21.825	21.943	22.068	22.070	22.070
Tc	99	2.1×10^{5}y	5.720	5.900	5.900	5.900	5.900	5.900	5.900	5.900	5.900	0
Ru	99	Stable	---	---	---	---	---	---	---	---	---	5.900
	101	Stable	6.200	6.200	6.200	6.200	6.200	6.200	6.200	6.200	6.200	6.200
	102	Stable	6.350	6.350	6.350	6.350	6.350	6.350	6.350	6.350	6.350	6.350
	103	40d	2.490	1.920	1.490	0.890	0.440	0.010	---	---	---	---
	104	Stable	6.600	6.600	6.600	6.600	6.600	6.600	6.600	6.600	6.600	6.600
	106	1.0y	5.620	5.460	5.300	5.020	4.650	3.180	2.810	1.400	0.006	0
			27.260	26.530	25.940	25.060	24.240	22.340	21.960	20.550	19.156	25.050
Rh	103	Stable	3.940	4.510	4.940	5.540	5.990	6.420	6.430	6.430	6.430	6.430
Pd	105	Stable	4.820	4.820	4.820	4.820	4.820	4.820	4.820	4.820	4.820	4.820
	106	Stable	0.730	0.890	1.050	1.330	1.700	3.170	3.540	4.950	6.344	6.350
	107	7×10^{6}y	4.800	4.800	4.800	4.800	4.800	4.800	4.800	4.800	4.800	0
	108	Stable	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300
	110	Stable	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840
			14.490	14.650	14.810	15.090	15.460	16.930	17.300	18.710	20.104	15.310

TABLE III
(Cont'd.)

Element	Mass No.	Half Life	Atoms/100 Atoms Pu^{239} Fissioned after Cooling: 0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Ag	107	Stable	---	---	---	---	---	---	---	---	---	4.800
	109	Stable	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700
	111	7.5d	0.392	0.098	0.025	0.002	---	---	---	---	---	---
			2.092	1.798	1.725	1.702	1.700	1.700	1.700	1.700	1.700	6.500
Cd	111	Stable	0.098	0.392	0.465	0.488	0.490	0.490	0.490	0.490	0.490	0.490
	112	Stable	0.185	9.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185
	113	Stable	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170
	114	Stable	0.127	0.127	0.127	0.127	0.127	0.127	0.127	0.127	0.127	0.127
	115	43d	0.010	0.008	0.006	0.004	0.002	---	---	---	---	---
	116	Stable	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
			0.598	0.890	0.961	0.982	0.982	0.980	0.980	0.980	0.980	0.980
In	115	Stable	0.084	0.086	0.088	0.090	0.092	0.094	0.094	0.094	0.094	0.094
Sn	117	Stable	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
	118	Stable	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
	119	Stable	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
	120	Stable	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
	122	Stable	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
	123	135d	0.064	0.059	0.055	0.047	0.038	0.014	0.010	0.002	---	---
	124	Stable	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180
	125	9.4d	0.026	0.008	0.003	0.000	---	---	---	---	---	---
			0.310	0.287	0.278	0.267	0.258	0.234	0.230	0.222	0.220	0.220
Sb	121	Stable	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
	123	Stable	0.064	0.069	0.073	0.081	0.090	0.114	0.118	0.126	0.128	0.128
	125	2.7y	0.227	0.242	0.244	0.243	0.236	0.205	0.196	0.152	0.020	0
	126	28d	0.116	0.080	0.054	0.027	0.009	---	---	---	---	---
	127	93h	0.026	---	---	---	---	---	---	---	---	---
			0.442	0.400	0.380	0.360	0.344	0.328	0.323	0.287	0.157	0.137
Te	125	Stable	0.007	0.010	0.013	0.017	0.024	0.055	0.064	0.108	0.240	0.260
	126	Stable	0.284	0.320	0.346	0.373	0.391	0.400	0.400	0.400	0.400	0.400
	127	115d	0.066	0.060	0.055	0.046	0.036	0.011	0.007	0.001	---	---
	128	Stable	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100
	130	Stable	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000
			4.457	4.490	4.514	4.536	4.551	4.566	4.571	4.609	4.740	4.760
I	127	Stable	0.528	0.560	0.565	0.574	0.584	0.609	0.613	0.619	0.620	0.620
	129	1.7×10^7y	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	---
	131	8d	0.420	0.114	0.031	0.002	---	---	---	---	---	---
	133	20.5h	0.059	---	---	---	---	---	---	---	---	---
			2.807	2.474	2.396	2.376	2.384	2.409	2.413	2.419	2.420	0.620
Xe	129	Stable	---	---	---	---	---	---	---	---	---	1.800
	131	Stable	4.480	4.786	4.869	4.898	4.900	4.900	4.900	4.900	4.900	4.900
	132	Stable	6.380	6.380	6.380	6.380	6.380	6.380	6.380	6.380	6.380	6.380
	133	5.3d	0.354	0.060	---	---	---	---	---	---	---	---
	134	Stable	6.300	6.300	6.300	6.300	6.300	6.300	6.300	6.300	6.300	6.300
	136	Stable	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
			23.514	23.526	23.549	23.578	23.580	23.580	23.580	23.580	23.580	25.380
Cs	133	Stable	5.837	6.190	6.250	6.250	6.250	6.250	6.250	6.250	6.250	6.250
	135	3×10^6y	6.220	6.220	6.220	6.220	6.220	6.220	6.220	6.220	6.220	---
	137	33y	5.800	5.800	5.800	5.790	5.770	5.720	5.700	5.580	4.810	---
			17.857	18.210	18.270	18.260	18.240	18.190	18.170	18.050	17.280	6.250
Ba	135	Stable	---	---	---	---	---	---	---	---	---	6.220
	137	Stable	---	---	---	0.010	0.030	0.080	0.100	0.220	0.990	5.800
	138	Stable	5.600	5.600	5.600	5.600	5.600	5.600	5.600	5.600	5.600	5.600
	140	12.8d	0.680	0.302	0.134	0.026	0.003	---	---	---	---	---
			6.280	5.902	5.734	5.636	5.633	5.680	5.700	5.820	6.590	17.620

TABLE III
(Cont'd.)

Element	Mass No.	Half Life	Atoms/100 Atoms Pu^{239} Fissioned after Cooling: 0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
La	139	Stable	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300
	140	40h	0.010	0.045	0.020	0.004	---	---	---	---	---	---
			5.310	5.345	5.320	5.304	5.300	5.300	5.300	5.300	5.300	5.300
Ce	140	Stable	4.310	4.653	4.846	4.970	4.997	5.00	5.00	5.000	5.000	5.000
	141	32d	1.520	1.100	0.810	0.430	0.190	0.002	0.00	---	---	---
	142	Stable	4.400	4.400	4.400	4.400	4.400	4.400	4.400	4.400	4.400	4.400
	143	33h	0.070	---	---	---	---	---	---	---	---	---
	144	280d	3.150	3.030	2.920	2.730	2.470	1.510	1.280	0.052	---	---
			13.450	13.183	12.976	12.530	12.057	10.912	10.680	9.452	9.400	9.400
Pr	141	Stable	3.180	3.600	3.890	4.270	4.510	4.698	4.700	4.700	4.700	4.700
	143	13.5d	0.710	0.380	0.178	0.039	0.005	---	---	---	---	---
			3.890	3.980	4.068	4.309	4.515	4.698	4.700	4.700	4.700	4.700
Nd	143	Stable	4.120	4.520	4.722	4.861	4.895	4.900	4.900	4.900	4.900	4.900
	144	Stable	0.550	0.670	0.780	0.970	1.230	2.190	2.420	3.648	3.700	3.700
	145	Stable	3.250	3.250	3.250	3.250	3.250	3.250	3.250	3.250	3.250	3.250
	146	Stable	2.900	2.900	2.900	2.900	2.900	2.900	2.900	2.900	2.900	2.900
	147	11.6d	0.315	0.123	0.048	0.007	---	---	---	---	---	---
	148	Stable	2.200	2.200	2.200	2.200	2.200	2.200	2.200	2.200	2.200	2.200
	150	Stable	1.580	1.580	1.580	1.580	1.580	1.580	1.580	1.580	1.580	1.580
			14.915	15.243	15.480	15.768	16.055	17.020	17.250	18.478	18.530	18.530
Pm	147	2.6y	2.170	2.337	2.382	2.373	2.310	1.998	1.905	1.460	0.171	0
	149	55h	0.047	---	---	---	---	---	---	---	---	---
	151	27h	0.015	---	---	---	---	---	---	---	---	---
			2.232	2.337	2.382	2.373	2.310	1.998	1.905	1.460	0.171	0
Sm	147	Stable	0.065	0.090	0.120	0.170	0.240	0.552	0.645	1.090	2.379	2.550
	149	Stable	1.853	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900
	151	73y	1.280	1.295	1.294	1.291	1.290	1.285	1.281	1.272	1.178	0
	152	Stable	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
	154	Stable	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
			4.398	4.485	4.514	4.561	4.630	4.937	5.026	5.462	6.657	5.650
Eu	151	Stable	0.005	0.005	0.006	0.009	0.010	0.015	0.019	0.028	0.122	1.300
	153	Stable	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480
	155	1.7y	0.179	0.177	0.173	0.168	0.161	0.128	0.119	0.080	0.003	0
	156	15d	0.010	0.005	0.003	---	---	---	---	---	---	---
			0.674	0.667	0.662	0.657	0.651	0.623	0.618	0.588	0.605	1.780
Gd	155	Stable	0.001	0.003	0.007	0.012	0.019	0.052	0.061	0.100	0.177	0.180
	156	Stable	0.070	0.075	0.077	0.080	0.080	0.080	0.080	0.080	0.080	0.080
	157	Stable	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
			0.091	0.098	0.104	0.112	0.119	0.152	0.161	0.200	0.277	0.280

TABLE IV

Fission Product Spectrum From Fast Fission (ca. 2 Mev Neutrons) of Pu^{239}

(135 Days Pile Irradiation)

Element	Atoms/(100 atoms Pu^{239} fissioned) after cooling:									
	0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Se	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Kr	1.158	1.158	1.156	1.154	1.151	1.138	1.134	1.109	0.986	0.828
Rb	0.810	0.810	0.812	0.814	0.817	0.830	0.834	0.859	0.982	0.330
Sr	4.420	4.258	4.121	3.391	3.762	3.497	4.480	3.400	2.890	2.080
Y	2.395	2.322	2.259	2.159	2.058	1.873	1.860	1.840	1.840	1.840
Zr	20.515	20.340	20.180	19.920	19.680	19.270	19.250	19.290	19.800	17.670
Nb	1.145	1.216	1.219	1.103	0.860	0.135	0.067	0.002	0	3.750
Mo	18.305	18.464	18.821	19.487	20.240	21.825	21.943	22.068	22.070	22.070
Tc	5.720	5.900	5.900	5.900	5.900	5.900	5.900	5.900	5.900	0
Ru	27.260	26.530	25.940	25.060	24.240	22.340	21.960	20.550	19.156	25.050
Rh	3.940	4.510	4.940	5.540	5.990	6.420	6.430	6.430	6.430	6.430
Pd	14.490	14.650	14.810	15.090	15.460	16.930	17.300	18.710	20.104	15.310
Ag	1.728	1.704	1.700	1.702	1.700	1.700	1.700	1.700	1.700	6.500
Cd	0.962	0.984	0.986	0.982	0.982	0.980	0.980	0.980	0.980	0.980
In	0.084	0.086	0.088	0.090	0.092	0.094	0.094	0.094	0.094	0.094
Sn	0.310	0.287	0.278	0.267	0.258	0.234	0.230	0.222	0.220	0.220
Sb	0.442	0.400	0.380	0.360	0.344	0.328	0.323	0.287	0.157	0.137
Te	4.457	4.490	4.514	4.536	4.551	4.566	4.571	4.609	4.740	4.760
I	2.807	2.474	2.396	2.376	2.384	2.409	2.413	2.419	2.420	0.620
Xe	23.514	23.526	23.549	23.578	23.580	23.580	23.580	23.580	23.580	25.380
Cs	17.857	18.210	18.270	18.260	18.240	18.190	18.170	18.050	17.280	6.250
Ba	6.280	5.902	5.734	5.636	5.633	5.680	5.700	5.820	6.590	17.620
La	5.310	5.345	5.320	5.304	5.300	5.300	5.300	5.300	5.300	5.300
Ce	13.450	13.183	12.976	12.530	12.057	10.912	10.680	9.452	9.400	9.400
Pr	3.890	3.890	4.068	4.309	4.515	4.698	4.700	4.700	4.700	4.700
Nd	14.915	15.243	15.480	15.768	16.055	17.020	17.250	18.478	18.530	18.530
Pm	2.232	2.337	2.382	2.373	2.310	1.998	1.905	1.460	0.171	0
Sm	4.398	4.485	4.514	4.561	4.630	4.937	5.026	5.462	6.657	5.650
Eu	0.674	0.667	0.662	0.657	0.651	0.623	0.618	0.588	0.605	1.780
Gd	0.091	0.098	0.104	0.112	0.119	0.152	0.161	0.200	0.277	0.280
	203.567	203.567	203.567	203.567	203.567	203.567	203.567	203.567	203.567	203.567

TABLE V

Fission Product Spectrum for PBR Discharged Fuel
(10% Pu^{239} 90% U^{238}) Irradiated 135 Days
and Cooled 15 Days

Element	Atomic Yield from Fission Per Cent	Grams Per 100 g-atoms Pu^{239} Fissioned	Wt. Per Cent of Total Fission Products	Weight Per Cent in Uranium Slug
Se	0.008	0.7	0.00	0.0000
Kr	1.158	98.6	0.41	0.0090
Rb	0.810	68.9	0.28	0.0062
Sr	4.258	380.0	1.57	0.0346
Y	2.322	209.3	0.86	0.0189
Zr	20.340	1909.5	7.89	0.1737
Nb	1.216	115.5	0.48	0.0106
Mo	18.464	1811.3	7.48	0.1647
Tc	5.900	584.1	2.41	0.0531
Ru	26.530	2762.3	11.41	0.2512
Rh	4.510	464.5	1.92	0.0423
Pd	14.650	1562.8	6.45	0.1420
Ag	1.704	185.7	0.77	0.0170
Cd	0.984	110.1	0.45	0.0099
In	0.086	9.9	0.04	0.0009
Sn	0.287	35.3	0.15	0.0033
Sb	0.400	41.2	0.17	0.0037
Te	4.490	610.0	2.52	0.0555
I	2.474	318.2	1.31	0.0288
Xe	23.526	3137.4	12.95	0.2853
Cs	18.210	2457.6	10.15	0.2235
Ba	5.902	815.1	3.37	0.0742
La	5.345	743.0	3.07	0.0676
Ce	13.183	1867.6	7.72	0.1700
Pr	3.980	561.9	2.32	0.0511
Nd	15.243	2218.3	9.16	0.2017
Pm	2.337	343.5	1.42	0.0313
Sm	4.485	674.9	2.79	0.0614
Eu	0.667	102.4	0.42	0.0092
Gd	0.098	15.3	0.06	0.0013
U + Pu	---	---	---	97.7980
	203.567	24214.9	100.00	100.0000

TABLE VI

Fission Product Spectrum for Fast Fission (ca. 2 Mev Neutrons) of Plutonium-239 (85 Days Irradiated)

Element	Mass No.	Half Life	Atoms/100 Atoms Fissioned After Cooling: 0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Se	82	Stable	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Kr	83	Stable	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098
	84	Stable	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
	85	9.4y	0.330	0.330	0.328	0.326	0.323	0.310	0.306	0.281	0.158	---
	86	Stable	0.530	0.530	0.530	0.530	0.530	0.530	0.530	0.530	0.530	0.530
			1.158	1.158	1.156	1.154	1.151	1.138	1.134	1.109	0.986	0.828
Rb	85	Stable	---	---	0.002	0.004	0.007	0.020	0.024	0.049	0.172	0.330
	87	6.2×10^{10}y	0.810	0.810	0.810	0.810	0.810	0.810	0.810	0.810	0.810	---
			0.810	0.810	0.812	0.814	0.817	0.830	0.834	0.859	0.982	0.330
Sr	87	Stable	---	---	---	---	---	---	---	---	---	0.810
	88	Stable	1.270	1.270	1.270	1.270	1.270	1.270	1.270	1.270	1.270	1.270
	89	54d	1.110	0.905	0.750	0.506	0.300	0.022	0.009	---	---	---
	90	19.9y	2.300	2.290	2.280	2.280	2.270	2.230	2.220	2.140	1.630	---
			4.680	4.465	4.300	4.056	3.840	3.522	3.499	3.410	2.900	2.080
Y	89	Stable	0.730	0.935	1.090	1.334	1.540	1.818	1.831	1.840	1.840	1.840
	91	61d	1.180	0.995	0.837	0.595	0.378	0.039	0.018	---	---	---
			1.910	1.930	1.927	1.929	1.918	1.857	1.849	1.840	1.840	1.840
Zr	90	Stable	---	0.010	0.020	0.020	0.030	0.070	0.080	0.160	0.670	2.300
	91	Stable	1.590	1.775	1.933	2.175	2.392	2.731	2.752	2.770	2.770	2.770
	92	Stable	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300
	93	9.5×10^{5}y	3.750	3.750	3.750	3.750	3.750	3.750	3.750	3.750	3.750	0
	94	Stable	4.200	4.200	4.200	4.200	4.200	4.200	4.200	4.200	4.200	4.200
	95	65d	3.440	2.960	2.525	1.835	1.198	0.142	0.070	---	---	---
	96	Stable	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100
			21.400	21.095	20.828	20.380	19.970	19.293	19.252	19.280	19.790	17.670
Nb	93	Stable	---	---	---	---	---	---	---	---	---	3.750
	95	35d	1.080	1.252	1.320	1.262	1.017	0.167	0.084	0.002	---	---
Mo	95	Stable	0.730	1.058	1.425	2.173	3.055	4.961	5.116	5.268	5.270	5.270
	97	Stable	5.200	5.200	5.200	5.200	5.200	5.200	5.200	5.200	5.200	5.200
	98	Stable	5.600	5.600	5.600	5.600	5.600	5.600	5.600	5.600	5.600	5.600
	99	67h	0.280	0.007	---	---	---	---	---	---	---	---
	100	Stable	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
			17.810	17.865	18.225	18.973	19.855	21.761	21.916	22.068	22.070	22.070
Tc	99	2.1×10^{5}y	5.620	5.893	5.900	5.900	5.900	5.900	5.900	5.900	5.900	---
Ru	99	Stable	---	---	---	---	---	---	---	---	---	5.900
	101	Stable	6.200	6.200	6.200	6.200	6.200	6.200	6.200	6.200	6.200	6.200
	102	Stable	6.350	6.350	6.350	6.350	6.350	6.350	6.350	6.350	6.350	6.350
	103	40d	3.370	2.600	2.005	1.207	0.597	0.019	0.006	---	---	---
	104	Stable	6.600	6.600	6.600	6.600	6.600	6.600	6.600	6.600	6.600	6.600
	106	1.0y	5.860	5.700	5.545	5.240	4.850	3.320	2.935	1.468	0.006	---
			28.380	27.450	26.700	25.597	24.597	22.489	22.091	20.618	19.156	25.050
Rh	103	Stable	3.060	3.830	4.425	5.223	5.833	6.411	6.424	6.430	6.430	6.430
Pd	105	Stable	4.820	4.820	4.820	4.820	4.820	4.820	4.820	4.820	4.820	4.820
	106	Stable	0.490	0.650	0.805	1.110	1.500	3.030	3.415	4.882	6.344	6.350
	107	7×10^{6}y	4.800	4.800	4.800	4.800	4.800	4.800	4.800	4.800	4.800	---
	108	Stable	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300	3.300
	110	Stable	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840
			14.250	14.410	14.565	14.870	15.260	16.790	17.175	18.642	20.104	15.310

TABLE VI
(Cont'd.)

Element	Mass No.	Half Life	Atoms/100 Atoms Fissioned After Cooling: 0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Ag	107	Stable	---	---	---	---	---	---	---	---	---	4.800
	109	Stable	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700
	111	7.5d	0.062	0.015	0.004	---	---	---	---	---	---	---
			1.762	1.715	1.704	1.700	1.700	1.700	1.700	1.700	1.700	6.500
Cd	111	Stable	0.428	0.475	0.486	0.490	0.490	0.490	0.490	0.490	0.490	0.490
	112	Stable	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185
	113	Stable	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170
	114	Stable	0.127	0.127	0.127	0.127	0.127	0.127	0.127	0.127	0.127	0.127
	115	43d	0.010	0.008	0.006	0.004	0.002	---	---	---	---	---
	116	Stable	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
			0.928	0.973	0.982	0.984	0.982	0.980	0.980	0.980	0.980	0.980
In	115	Stable	0.084	0.086	0.088	0.090	0.092	0.094	0.094	0.094	0.094	0.094
Sn	117-124	---	0.284	0.279	0.275	0.267	0.258	0.236	0.230	0.222	0.220	0.220
	125	9.4d	0.042	0.014	0.004	---	---	---	---	---	---	---
			0.326	0.293	0.279	0.267	0.258	0.236	0.230	0.222	0.220	0.220
Sb	121	Stable	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
	123	Stable	0.064	0.069	0.073	0.081	0.090	0.112	0.118	0.126	0.128	0.128
	125	2.7y	0.218	0.246	0.255	0.249	0.242	0.211	0.201	0.156	0.020	---
	126	28d	0.167	0.115	0.080	0.038	0.014	---	---	---	---	---
	127	93h	0.040	0.002	---	---	---	---	---	---	---	---
			0.498	0.441	0.417	0.377	0.355	0.332	0.328	0.291	0.157	0.137
Te	125	Stable	---	---	0.001	0.011	0.018	0.049	0.059	0.104	0.240	0.260
	126	Stable	0.233	0.285	0.320	0.362	0.386	0.400	0.400	0.400	0.400	0.400
	127	115d	0.052	0.053	0.048	0.040	0.032	0.010	0.006	0.001	---	---
	128	Stable	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100
	130	Stable	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000
			4.385	4.438	4.469	4.513	4.536	4.559	4.565	4.605	4.740	4.760
I	127	Stable	0.528	0.565	0.572	0.580	0.588	0.610	0.614	0.619	0.620	0.620
	129	1.7×10^7y	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	---
	131	8d	0.665	0.182	0.049	0.004	---	---	---	---	---	---
	133	20.5h	0.093	---	---	---	---	---	---	---	---	---
			3.086	2.547	2.421	2.384	2.388	2.410	2.414	2.419	2.420	0.620
Xe	129	Stable	---	---	---	---	---	---	---	---	---	1.800
	131	Stable	4.235	4.718	4.851	4.896	4.900	4.900	4.900	4.900	4.900	4.900
	132	Stable	6.380	6.380	6.380	6.380	6.380	6.380	6.380	6.380	6.380	6.380
	133	5.3d	0.561	0.092	0.014	---	---	---	---	---	---	---
	134	Stable	6.300	6.300	6.300	6.300	6.300	6.300	6.300	6.300	6.300	6.300
	136	Stable	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
			23.476	23.490	23.545	23.576	23.580	23.580	23.580	23.580	23.580	25.380
Cs	133	Stable	5.596	6.158	6.236	6.250	6.250	6.250	6.250	6.250	6.250	6.250
	135	3×10^6y	6.220	6.220	6.220	6.220	6.220	6.220	6.220	6.220	6.220	---
	137	33y	5.800	5.800	5.800	5.790	5.770	5.720	5.700	5.580	4.810	---
			17.616	18.178	18.256	18.260	18.240	18.190	18.170	18.050	17.280	6.250
Ba	135	Stable	---	---	---	---	---	---	---	---	---	6.220
	137	Stable	---	---	---	0.010	0.030	0.080	0.100	0.220	0.990	5.800
	138	Stable	5.600	5.600	5.600	5.600	5.600	5.600	5.600	5.600	5.600	5.600
	140	12.8d	1.080	0.479	0.213	0.042	0.005	---	---	---	---	---
			6.680	6.079	5.813	5.652	5.635	5.680	5.700	5.820	6.590	17.620
La	139	Stable	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300
	140	40h	0.142	0.073	0.032	0.006	---	---	---	---	---	---
			5.442	5.373	5.332	5.306	5.300	5.300	5.300	5.300	5.300	5.300

TABLE VI
(Cont'd.)

Element	Mass No.	Half Life	Atoms/100 Atoms Fissioned After Cooling: 0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Ce	140	Stable	3.778	4.448	4.755	4.952	4.995	5.000	5.000	5.000	5.000	5.000
	141	32d	2.182	1.595	1.165	0.620	0.266	0.004	0.001	---	---	---
	142	Stable	4.400	4.400	4.400	4.400	4.400	4.400	4.400	4.400	4.400	4.400
	143	33h	0.115	---	---	---	---	---	---	---	---	---
	144	280d	3.320	3.200	3.082	2.880	2.600	1.595	1.350	0.548	---	---
			13.795	13.643	13.402	12.852	12.261	10.999	10.751	9.948	9.400	9.400
Pr	141	Stable	2.518	3.105	3.535	4.080	4.434	4.696	4.699	4.700	4.700	4.700
	143	13.5d	1.130	0.583	0.273	0.060	0.208	---	---	---	---	---
			3.648	3.688	3.808	4.140	4.442	4.696	4.699	4.700	4.700	4.700
Nd	143	Stable	3.655	4.317	4.627	4.840	4.892	4.900	4.900	4.900	4.900	4.900
	144	Stable	0.380	0.500	0.618	0.820	1.100	2.105	2.350	3.152	3.700	3.700
	145	Stable	3.250	3.250	3.250	3.250	3.250	3.250	3.250	3.250	3.250	3.250
	146	Stable	2.900	2.900	2.900	2.900	2.900	2.900	2.900	2.900	2.900	2.900
	147	11.6d	0.500	0.194	0.076	0.012	0.001	---	---	---	---	---
	148	Stable	2.200	2.200	2.200	2.200	2.200	2.200	2.200	2.200	2.200	2.200
	150	Stable	1.580	1.580	1.580	1.580	1.580	1.580	1.580	1.580	1.580	1.580
			14.465	14.941	15.251	15.602	15.923	16.935	17.180	17.982	18.530	18.530
Pm	147	2.6y	2.000	2.276	2.364	2.378	2.319	2.010	1.915	1.465	0.173	---
	149	55h	0.076	---	---	---	---	---	---	---	---	---
	151	27h	0.025	---	---	---	---	---	---	---	---	---
			2.101	2.276	2.364	2.378	2.319	2.010	1.915	1.465	0.173	0
Sm	147	Stable	0.050	0.080	0.110	0.160	0.230	0.540	0.635	1.085	2.377	2.550
	149	Stable	1.824	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900	1.900
	151	73y	1.275	1.300	1.299	1.296	1.295	1.290	1.286	1.277	1.183	0
	152	Stable	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
	154	Stable	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
			4.349	4.480	4.509	4.556	4.625	4.920	5.021	5.462	6.660	5.650
Eu	151	Stable	---	---	0.001	0.004	0.005	0.010	0.014	0.023	0.117	1.300
	153	Stable	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480
	155	1.7y	0.180	0.177	0.173	0.168	0.161	0.128	0.119	0.080	0.003	---
	156	15d	0.010	0.005	0.003	0.001	---	---	---	---	---	---
			0.670	0.662	0.657	0.653	0.646	0.618	0.613	0.583	0.600	1.780
Gd	155	Stable	---	0.003	0.007	0.012	0.019	0.052	0.061	0.100	0.177	0.180
	156	Stable	0.070	0.075	0.077	0.079	0.080	0.080	0.080	0.080	0.080	0.080
	157	Stable	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
			0.090	0.098	0.104	0.111	0.119	0.152	0.161	0.200	0.277	0.280

TABLE VII

Fission Product Spectrum For Fast Fission (ca. 2 Mev Neutrons) of Pu^{239}

(85 Days Pile Irradiation)

Element	Atoms/(100 atoms Pu^{239} fissioned) after cooling:									
	0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Se	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Kr	1.158	1.158	1.156	1.154	1.151	1.138	1.134	1.109	0.986	0.828
Rb	0.810	0.810	0.812	0.814	0.817	0.830	0.834	0.859	0.982	0.330
Sr	4.680	4.465	4.300	4.056	3.840	3.522	3.499	3.410	2.900	2.080
Y	1.910	1.930	1.927	1.929	1.918	1.857	1.849	1.840	1.840	1.840
Zr	21.400	21.095	20.828	20.380	19.970	19.293	19.252	19.280	19.790	17.670
Nb	1.080	1.252	1.320	1.262	1.017	0.167	0.084	0.002	---	3.750
Mo	17.810	17.865	18.225	18.973	19.855	21.761	21.916	22.068	22.070	22.070
Tc	5.620	5.893	5.900	5.900	5.900	5.900	5.900	5.900	5.900	---
Ru	28.380	27.450	26.700	25.597	24.597	22.489	22.091	20.618	19.156	25.050
Rh	3.060	3.830	4.425	5.223	5.833	6.411	6.424	6.430	6.430	6.430
Pd	14.250	14.410	14.565	14.870	15.260	16.790	17.175	18.642	20.104	15.310
Ag	1.762	1.715	1.704	1.700	1.700	1.700	1.700	1.700	1.700	6.500
Cd	0.928	0.973	0.982	0.984	0.982	0.980	0.980	0.980	0.980	0.980
In	0.084	0.086	0.088	0.090	0.092	0.094	0.094	0.094	0.094	0.094
Sn	0.326	0.293	0.279	0.267	0.258	0.236	0.230	0.222	0.220	0.220
Sb	0.498	0.441	0.417	0.377	0.355	0.334	0.328	0.291	0.157	0.137
Te	4.385	4.438	4.469	4.513	4.536	4.559	4.565	4.605	4.740	4.760
I	3.086	2.547	2.421	2.384	2.388	2.410	2.414	2.419	2.420	0.620
Xe	23.476	23.490	23.545	23.576	23.580	23.580	23.580	23.580	23.580	25.380
Cs	17.616	18.178	18.256	18.260	18.240	18.190	18.170	18.050	17.280	6.250
Ba	6.680	6.079	5.813	5.652	5.635	5.680	5.700	5.820	6.590	17.620
La	5.442	5.373	5.332	5.306	5.300	5.300	5.300	5.300	5.300	5.300
Ce	13.795	13.643	13.402	12.852	12.261	10.999	10.751	9.948	9.400	9.400
Pr	3.648	3.688	3.808	4.140	4.442	4.696	4.699	4.700	4.700	4.700
Nd	14.465	14.941	15.251	15.602	15.923	16.935	17.180	17.982	18.530	18.530
Pm	2.101	2.276	2.364	2.378	2.319	2.010	1.915	1.465	0.173	----
Sm	4.349	4.480	4.509	4.556	4.625	4.930	5.021	5.462	6.660	5.650
Eu	0.670	0.662	0.657	0.653	0.646	0.618	0.613	0.583	0.600	1.780
Gd	0.090	0.098	0.104	0.111	0.119	0.152	0.161	0.200	0.277	0.280
	203.567	203.567	203.567	203.567	203.567	203.567	203.567	203.567	203.567	203.567

TABLE VIII

Fission Product Spectrum for PBR Discharged Fuel
(10% Pu^{239} 90% U^{238}) Irradiated 85 Days
and Cooled 15 Days

Element	Atomic Yield from Fission Per Cent	Grams Per 100 g-atoms Pu^{239} Fissioned	Wt. Per Cent of Total Fission Products	Weight Per Cent in Uranium Slug
Se	0.008	0.7	0.003	0.0001
Kr	1.158	98.6	0.410	0.0090
Rb	0.810	68.9	0.286	0.0063
Sr	4.465	398.4	1.655	0.0364
Y	1.930	173.7	0.722	0.0159
Zr	21.095	1980.4	8.229	0.1812
Nb	1.252	118.9	0.494	0.0109
Mo	17.865	1754.4	7.290	0.1605
Tc	5.893	583.4	2.424	0.0534
Ru	27.450	2832.3	11.768	0.2591
Rh	3.830	394.5	1.639	0.0361
Pd	14.410	1537.4	6.388	0.1407
Ag	1.715	187.0	0.777	0.0171
Cd	0.973	108.9	0.453	0.0100
In	0.086	9.9	0.041	0.0009
Sn	0.293	35.3	0.147	0.0032
Sb	0.441	55.2	0.229	0.0050
Te	4.438	473.4	1.967	0.0433
I	2.547	327.8	1.362	0.0300
Xe	23.490	2132.7	13.016	0.2867
Cs	18.178	2453.3	10.193	0.2244
Ba	6.079	839.9	3.490	0.0768
La	5.373	746.9	3.104	0.0684
Ce	13.643	1933.2	8.033	0.1769
Pr	3.688	521.2	2.166	0.0477
Nd	14.941	2175.1	9.037	0.1990
Pm	2.276	334.6	1.390	0.0306
Sm	4.480	674.2	2.801	0.0617
Eu	0.662	101.6	0.422	0.0093
Gd	0.098	15.3	0.064	0.0014
U + Pu	---	---	---	97.7980
	203.567	24066.1	100.000	100.0000

TABLE IX

Fission Product Spectrum From Fast Fission (ca. 1 Mev Neutrons) of Uranium 235 (135 Days Irradiated)

Element	Mass No.	Half Life	Atoms/100 Atoms Fissioned After Cooling: 0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Se	77	Stable	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
	78	Stable	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
	79	6×10^4y	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	---
	80	Stable	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
	82	Stable	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
			0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.354
Br	79	Stable	---	---	---	---	---	---	---	---	---	0.042
	81	Stable	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133
			0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.175
Kr	83	Stable	0.382	0.382	0.382	0.382	0.382	0.382	0.382	0.382	0.382	0.382
	84	Stable	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625
	85	9.4y	1.142	1.142	1.138	1.130	1.120	1.075	1.061	0.975	0.548	---
	86	Stable	1.644	1.644	1.644	1.644	1.644	1.644	1.644	1.644	1.644	1.644
			3.793	3.793	3.789	3.781	3.771	3.726	3.712	3.626	3.199	2.651
Rb	85	Stable	---	---	0.004	0.012	0.022	0.067	0.081	0.167	0.594	1.142
	87	6.2×10^{10}y	2.890	2.890	2.890	2.890	2.890	2.890	2.890	2.890	2.890	---
			2.890	2.890	2.894	2.902	2.912	2.957	2.971	3.057	3.484	1.142
Sr	87	Stable	---	---	---	---	---	---	---	---	---	2.890
	88	Stable	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500
	89	54d	1.955	1.610	1.321	0.888	0.527	0.016	---	---	---	---
	90	19.9y	4.410	4.395	4.380	4.360	4.340	4.270	4.250	4.095	3.115	---
			9.865	9.505	9.201	8.748	8.367	7.786	7.750	7.595	6.615	6.390
Y	89	Stable	2.230	2.575	2.864	3.297	3.658	4.169	4.185	4.185	4.185	4.185
	91	61d	2.715	2.280	1.918	1.362	0.864	0.077	0.039	---	---	---
			4.945	4.855	4.782	4.659	4.522	4.246	4.224	4.185	4.185	4.185
Zr	90	Stable	0.010	0.025	0.040	0.060	0.080	0.150	0.170	0.325	1.305	4.420
	91	Stable	2.595	3.030	3.392	3.948	4.446	5.233	5.271	5.310	5.310	5.310
	92	Stable	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300
	93	9.5×10^5y	5.425	5.425	5.425	5.425	5.425	5.425	5.425	5.425	5.425	0
	94	Stable	5.700	5.700	5.700	5.700	5.700	5.700	5.700	5.700	5.700	5.700
	95	65d	3.595	3.050	2.610	1.900	1.245	0.142	0.077	---	---	---
	96	Stable	6.750	6.750	6.750	6.750	6.750	6.750	6.750	6.750	6.750	6.750
			29.375	29.280	29.217	29.083	28.946	28.700	28.693	28.810	29.790	27.480
Nb	93	Stable	---	---	---	---	---	---	---	---	---	5.425
	95	35d	2.470	1.580	1.460	1.420	1.105	0.168	0.093	0.010	---	---
			2.470	1.580	1.460	1.420	1.105	0.168	0.093	0.010	0	5.425
Mo	95	Stable	0.705	2.140	2.700	3.450	4.420	6.460	6.600	6.760	6.770	6.770
	97	Stable	6.560	6.560	6.560	6.560	6.560	6.560	6.560	6.560	6.560	6.560
	98	Stable	6.240	6.240	6.240	6.240	6.240	6.240	6.240	6.240	6.240	6.240
	99	67h	0.190	---	---	---	---	---	---	---	---	---
	100	Stable	6.750	6.750	6.750	6.750	6.750	6.750	6.750	6.750	6.750	6.750
			20.445	21.690	22.250	23.000	23.970	26.010	26.150	26.310	26.320	26.320
Tc	99	2.1×10^5y	6.010	6.200	6.200	6.200	6.200	6.200	6.200	6.200	6.200	---
Ru	99	Stable	---	---	---	---	---	---	---	---	---	6.200
	101	Stable	6.050	6.050	6.050	6.050	6.050	6.050	6.050	6.050	6.050	6.050
	102	Stable	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300
	103	40d	1.550	1.195	0.926	0.554	0.274	0.006	0.002	---	---	---
	104	Stable	2.775	2.775	2.775	2.775	2.775	2.775	2.775	2.775	2.775	2.775
	106	1.0y	0.416	0.405	0.393	0.372	0.345	0.236	0.208	0.104	---	---
			16.091	15.725	15.444	15.051	14.744	14.367	14.335	14.229	14.125	20.325

TABLE IX
(Cont'd.)

Element	Mass No.	Half Life	Atoms/100 Atoms Fissioned After Cooling: 0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Rh	103	Stable	2.450	2.805	3.074	3.446	3.726	3.994	3.998	4.000	4.000	4.000
Pd	105	Stable	1.026	1.026	1.026	1.026	1.026	1.026	1.026	1.026	1.026	1.026
	106	Stable	0.054	0.065	0.077	0.098	0.125	0.234	0.262	0.366	0.470	0.470
	107	7 x 10^6y	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280	---
	108	Stable	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163
	110	Stable	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079
			1.602	1.613	1.625	1.646	1.673	1.782	1.810	1.914	2.018	1.738
Ag	107	Stable	---	---	---	---	---	---	---	---	---	0.280
	109	Stable	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087
	111	7.5d	0.054	0.013	0.003	---	---	---	---	---	---	---
			0.141	0.100	0.090	0.087	0.087	0.087	0.087	0.087	0.087	0.367
Cd	111	Stable	0.013	0.054	0.064	0.067	0.067	0.067	0.067	0.067	0.067	0.067
	112	Stable	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
	113	Stable	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
	114	Stable	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
	115	43d	0.005	0.004	0.003	0.002	0.001	---	---	---	---	---
	116	Stable	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
			0.192	0.232	0.241	0.243	0.242	0.241	0.241	0.241	0.241	0.241
In	115	Stable	0.040	0.041	0.042	0.043	0.044	0.045	0.045	0.045	0.045	0.045
Sn	117	Stable	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
	118	Stable	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
	119	Stable	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	120	Stable	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	122	Stable	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
	123	135d	0.026	0.024	0.023	0.019	0.016	0.006	0.004	0.001	---	---
	124	Stable	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
	125	9.4d	0.012	0.004	0.001	---	---	---	---	---	---	---
			0.371	0.361	0.357	0.352	0.349	0.339	0.337	0.334	0.333	0.333
Sb	121	Stable	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
	123	Stable	0.027	0.029	0.030	0.034	0.037	0.047	0.049	0.052	0.053	0.053
	125	2.7y	0.108	0.115	0.116	0.115	0.112	0.097	0.093	0.072	0.009	---
	126	28d	0.052	0.036	0.024	0.012	0.004	---	---	---	---	---
	127	93h	0.011	---	---	---	---	---	---	---	---	---
			0.253	0.235	0.225	0.216	0.208	0.199	0.197	0.179	0.117	0.108
Te	125	Stable	0.003	0.004	0.006	0.008	0.011	0.026	0.030	0.051	0.114	0.123
	126	Stable	0.128	0.144	0.156	0.168	0.176	0.180	0.180	0.180	0.180	0.180
	127	115d	0.028	0.025	0.023	0.019	0.015	0.005	0.003	---	---	---
	128	Stable	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430
	130	Stable	1.525	1.525	1.525	1.525	1.525	1.525	1.525	1.525	1.525	1.525
			2.114	2.128	2.140	2.150	2.157	2.166	2.168	2.186	2.249	2.258
I	127	Stable	0.221	0.235	0.237	0.241	0.245	0.255	0.257	0.260	0.260	0.260
	129	1.7 x 10^7y	0.790	0.790	0.790	0.790	0.790	0.790	0.790	0.790	0.790	---
	131	8d	0.270	0.073	0.020	0.001	---	---	---	---	---	---
	133	20.5h	0.061	---	---	---	---	---	---	---	---	---
			1.342	1.098	1.047	1.032	1.035	1.045	1.047	1.050	1.050	0.260
Xe	129	Stable	---	---	---	---	---	---	---	---	---	0.790
	131	Stable	2.840	3.037	3.090	3.109	3.110	3.110	3.110	3.110	3.110	3.110
	132	Stable	4.450	4.450	4.450	4.450	4.450	4.450	4.450	4.450	4.450	4.450
	133	5.3d	0.375	0.064	0.009	---	---	---	---	---	---	---
	134	Stable	7.810	7.810	7.810	7.810	7.810	7.810	7.810	7.810	7.810	7.810
	136	Stable	6.420	6.420	6.420	6.420	6.420	6.420	6.420	6.420	6.420	6.420
			21.895	21.781	21.779	21.789	21.790	21.790	21.790	21.790	21.790	22.580

TABLE IX
(Cont'd.)

Element	Mass No.	Half Life	Atoms/100 Atoms Fissioned After Cooling									
			0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Cs	133	Stable	6.184	6.556	6.611	6.620	6.620	6.620	6.620	6.620	6.620	6.620
	135	3 x 10^6y	6.560	6.560	6.560	6.560	6.560	6.560	6.560	6.560	6.560	---
	137	33y	6.190	6.190	6.190	6.180	6.160	6.110	6.080	5.960	5.140	---
			18.934	19.306	19.361	19.360	19.340	19.290	19.260	19.140	18.320	6.620
Ba	135	Stable	---	---	---	---	---	---	---	---	---	6.560
	137	Stable	---	---	---	0.010	0.030	0.080	0.110	0.230	1.050	6.190
	138	Stable	6.120	6.120	6.120	6.120	6.120	6.120	6.120	6.120	6.120	6.120
	140	12.8d	0.788	0.351	0.155	0.030	0.004	---	---	---	---	---
			6.908	6.471	6.275	6.160	6.154	6.200	6.230	6.350	7.170	18.870
La	139	Stable	6.250	6.250	6.250	6.250	6.250	6.250	6.250	6.250	6.250	6.250
	140	40h	0.012	0.052	0.073	0.005	---	---	---	---	---	---
			6.262	6.302	6.273	6.255	6.250	6.250	6.250	6.250	6.250	6.250
Ce	140	Stable	5.000	5.397	5.622	5.765	5.796	5.800	5.800	5.800	5.800	5.800
	141	33d	1.705	1.242	0.915	0.486	0.215	0.002	---	---	---	---
	142	Stable	5.190	5.190	5.190	5.190	5.190	5.190	5.190	5.190	5.190	5.190
	143	33h	0.074	---	---	---	---	---	---	---	---	---
	144	282d	3.990	3.840	3.695	3.455	3.130	1.915	1.625	0.066	---	---
			15.959	15.669	15.422	14.896	14.331	12.907	12.615	11.056	10.990	10.990
Pr	141	Stable	3.595	4.058	4.385	4.814	5.085	5.298	5.300	5.300	5.300	5.300
	143	13.7d	0.755	0.403	0.188	0.041	0.005	---	---	---	---	---
			4.350	4.461	4.573	4.855	5.090	5.298	5.300	5.300	5.300	5.300
Nd	143	Stable	4.361	4.787	5.002	5.149	5.185	5.190	5.190	5.190	5.190	5.190
	144	Stable	0.780	0.930	1.075	1.315	1.640	2.855	3.145	4.704	4.770	4.770
	145	Stable	4.320	4.320	4.320	4.320	4.320	4.320	4.320	4.320	4.320	4.320
	146	Stable	3.870	3.870	3.870	3.870	3.870	3.870	3.870	3.870	3.870	3.870
	147	11.3d	0.400	0.157	0.061	0.009	---	---	---	---	---	---
	148	Stable	2.280	2.280	2.280	2.280	2.280	2.280	2.280	2.280	2.280	2.280
	150	Stable	0.735	0.735	0.735	0.735	0.735	0.735	0.735	0.735	0.735	0.735
			16.746	17.079	17.343	17.678	18.030	19.250	19.540	21.099	21.165	21.165
Pm	147	2.6y	2.755	2.960	3.030	3.010	2.955	2.537	2.420	1.855	0.217	---
	149	55h	0.029	---	---	---	---	---	---	---	---	---
	151	27h	0.005	---	---	---	---	---	---	---	---	---
			2.789	2.960	3.030	3.010	2.955	2.537	2.420	1.855	0.217	0
Sm	147	Stable	0.085	0.123	0.149	0.221	0.285	0.703	0.820	1.385	3.023	3.240
	149	Stable	1.156	1.185	1.185	1.185	1.185	1.185	1.185	1.185	1.185	1.185
	151	73y	0.458	0.464	0.464	0.463	0.462	0.460	0.458	0.456	0.422	---
	152	Stable	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282
	154	Stable	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067
			2.048	2.121	2.147	2.218	2.281	2.697	2.812	3.375	4.979	4.774
Eu	151	Stable	0.002	0.001	0.001	0.002	0.003	0.005	0.007	0.009	0.043	0.465
	153	Stable	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142
	155	1.7y	0.029	0.029	0.028	0.027	0.026	0.021	0.019	0.013	0.001	---
	156	15d	0.002	0.001	---	---	---	---	---	---	---	---
			0.175	0.173	0.171	0.171	0.171	0.168	0.168	0.164	0.186	0.607
Gd	155	Stable	---	---	0.001	0.002	0.003	0.008	0.010	0.016	0.028	0.029
	156	Stable	0.011	0.012	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
	157	Stable	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
			0.018	0.019	0.021	0.022	0.023	0.028	0.030	0.036	0.048	0.049

TABLE X

Fission Product Spectrum From Fast Fission (ca. 1 Mev Neutrons) of U^{235}

(135 Days Pile Irradiation)

Element	Atoms/100 Atoms U^{235} Fissioned After Cooling:									
	0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Se	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.354
Br	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.175
Kr	3.793	3.793	3.789	3.781	3.771	3.726	3.712	3.626	3.199	2.651
Rb	2.890	2.890	2.894	2.902	2.912	2.957	2.971	3.057	3.484	1.142
Sr	9.865	9.505	9.201	8.748	8.367	7.786	7.750	7.595	6.615	6.390
Y	4.945	4.855	4.782	4.659	4.522	4.246	4.224	4.185	4.185	4.185
Zr	29.375	29.280	29.217	29.083	28.946	28.700	28.693	28.810	29.790	27.480
Nb	2.470	1.580	1.460	1.420	1.105	0.168	0.093	0.010	---	5.425
Mo	20.445	21.690	22.250	23.000	23.970	26.010	26.150	26.310	26.320	26.320
Tc	6.010	6.200	6.200	6.200	6.200	6.200	6.200	6.200	6.200	---
Ru	16.091	15.725	15.444	15.051	14.744	14.367	14.335	14.229	14.125	20.325
Rh	2.450	2.805	3.074	3.446	3.726	3.994	3.998	4.000	4.000	4.000
Pd	1.602	1.613	1.625	1.646	1.673	1.782	1.810	1.914	2.018	1.738
Ag	0.141	0.100	0.090	0.087	0.087	0.087	0.087	0.087	0.087	0.367
Cd	0.192	0.232	0.241	0.243	0.242	0.241	0.241	0.241	0.241	0.241
In	0.040	0.041	0.042	0.043	0.044	0.045	0.045	0.045	0.045	0.045
Sn	0.371	0.361	0.357	0.352	0.349	0.339	0.337	0.334	0.333	0.333
Te	2.114	2.128	2.140	2.150	2.157	2.166	2.168	2.186	2.249	2.258
I	1.342	1.098	1.047	1.032	1.035	1,045	1.047	1.050	1.050	0.260
Xe	21.895	21.781	21.779	21.789	21.790	21.790	21.790	21.790	21.790	22.580
Cs	18.934	19.306	19.361	19.360	19.340	19.290	19.260	19.140	18.320	6.620
Ba	6.908	6.471	6.275	6.160	6.154	6.200	6.230	6.350	7.170	18.870
La	6.262	6.302	6.273	6.255	6.250	6.250	6.250	6.250	6.250	6.250
Ce	15.959	15.669	15.422	14.896	14.331	12.907	12.615	11.056	10.990	10.990
Pr	4.350	4.461	4.573	4.855	5.090	5.298	5.300	5.300	5.300	5.300
Nd	16.746	17.079	17.343	17.678	18.030	19.250	19.540	21.099	21.165	21.165
Pm	2.789	2.960	3.030	3.010	2.955	2.537	2.420	1.855	0.217	---
Sm	2.048	2.121	2.147	2.218	2.281	2.697	2.812	3.395	4.979	4.774
Eu	0.175	0.173	0.171	0.171	0.171	0.168	0.168	0.164	0.186	0.607
Gd	0.018	0.019	0.021	0.022	0.023	0.028	0.030	0.036	0.048	0.049
	201.002	201.002	201.002	201.002	201.002	201.002	201.002	201.002	201.002	201.002

TABLE XI

Fission Product Spectrum of EBR-II Discharged Fuel (10% Pu^{239}, 20% U^{235}, 70% U^{238}) Irradiated 135 Days and Cooled 15 Days

Element	Atomic Yield from Fission Per Cent	Grams Per 100 g-atoms Pu^{239} Fissioned	Wt. Per Cent of Total Fission Product	Weight Per Cent in Uranium Slug
Se	0.267	21.6	0.09	0.0020
Br	0.089	7.2	0.03	0.0007
Kr	2.915	248.0	1.04	0.0229
Rb	2.197	190.6	0.80	0.0176
Sr	7.756	691.4	2.91	0.0641
Y	4.011	360.9	1.52	0.0335
Zr	26.299	2465.9	10.37	0.2283
Nb	1.458	138.6	0.58	0.0128
Mo	20.615	2021.3	8.50	0.1872
Tc	6.100	603.9	2.54	0.0559
Ru	19.326	1998.6	8.41	0.1852
Rh	3.373	347.5	1.46	0.0321
Pd	5.958	634.8	2.67	0.0588
Ag	0.635	69.2	0.29	0.0064
Cd	0.483	54.2	0.23	0.0051
In	0.056	6.4	0.03	0.0007
Sn	0.337	40.9	0.17	0.0037
Sb	0.290	32.1	0.14	0.0031
Te	2.916	386.7	1.63	0.0359
I	1.557	200.3	0.84	0.0185
Xe	22.362	2987.8	12.57	0.2767
Cs	18.941	2557.9	10.76	0.2369
Ba	6.281	867.5	3.65	0.0804
La	5.983	831.8	3.50	0.0771
Ce	14.840	2103.5	8.85	0.1949
Pr	4.301	607.4	2.56	0.0564
Nd	16.467	2393.5	10.07	0.2217
Pm	2.752	404.5	1.70	0.0374
Sm	2.909	437.0	1.84	0.0405
Eu	0.337	51.8	0.22	0.0048
Gd	0.046	7.1	0.03	0.0007
U + Pu	---	---	---	97.7980
	201.857	23769.9	100.00	100.0000

TABLE XII

Fission Product Spectrum From Fast Fission (ca. 1 Mev Neutrons) of U^{235}

Atoms/100 Atoms Fissioned (85-days-irradiated) After Cooling:

Element	Mass No.	Half Life	0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Se	77	Stable	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
	78	Stable	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
	79	6.5×10^4y	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	---
	80	Stable	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
	82	Stable	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
			0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.354
Br	79	Stable	---	---	---	---	---	---	---	---	---	0.042
	81	Stable	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133
			0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.175
Kr	83	Stable	0.382	0.382	0.382	0.382	0.382	0.382	0.382	0.382	0.382	0.382
	84	Stable	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625
	85	9.4y	1.142	1.142	1.135	1.128	1.118	1.073	1.059	0.972	0.547	---
	86	Stable	1.644	1.644	1.644	1.644	1.644	1.644	1.644	1.644	1.644	1.644
			3.793	3.793	3.786	3.779	3.769	3.724	3.710	3.623	3.198	2.651
Rb	85	Stable	---	---	0.007	0.014	0.024	0.069	0.083	0.170	0.595	1.142
	87	6.2×10^{10}y	2.890	2.890	2.890	2.890	2.890	2.890	2.890	2.890	2.890	---
			2.890	2.890	2.897	2.904	2.914	2.959	2.973	3.060	3.485	1.142
Sr	87	Stable	---	---	---	---	---	---	---	---	---	2.890
	88	Stable	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500
	89	54d	2.524	2.060	1.706	1.151	0.682	0.050	0.020	---	---	---
	90	19.9y	4.420	4.400	4.382	4.373	4.363	4.286	4.267	4.113	3.133	---
			10.444	9.960	9.588	9.024	8.545	7.836	7.787	7.613	6.633	6.390
Y	89	Stable	1.661	2.125	2.479	3.034	3.503	4.135	4.165	4.185	4.185	4.185
	91	61d	2.262	1.910	1.605	1.141	0.725	0.075	0.035	---	---	---
			3.923	4.035	4.084	4.175	4.228	4.210	4.200	4.185	4.185	4.185
Zr	90	Stable	---	0.020	0.038	0.047	0.057	0.134	0.153	0.307	1.287	4.420
	91	Stable	3.048	3.400	3.705	4.169	4.585	5.235	5.275	5.310	5.310	5.310
	92	Stable	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300
	93	5×10^6y	5.425	5.425	5.425	5.425	5.425	5.425	5.425	5.425	5.425	---
	94	Stable	5.700	5.700	5.700	5.700	5.700	5.700	5.700	5.700	5.700	5.700
	95	65d	4.446	3.802	3.245	2.358	1.539	0.182	0.090	---	---	---
	96	Stable	6.750	6.750	6.750	6.750	6.750	6.750	6.750	6.750	6.750	6.750
			30.669	30.397	30.163	29.749	29.356	28.726	28.693	28.792	29.772	27.480
Nb	93	Stable	---	---	---	---	---	---	---	---	---	5.425
	95	35d	1.388	1.610	1.696	1.622	1.306	0.215	0.108	0.003	---	---
			1.388	1.610	1.696	1.622	1.306	0.215	0.108	0.003	0	5.425
Mo	95	Stable	0.936	1.358	1.829	2.790	3.925	6.373	6.572	6.767	6.770	6.770
	97	Stable	6.560	6.560	6.560	6.560	6.560	6.560	6.560	6.560	6.560	6.560
	98	Stable	6.240	6.240	6.240	6.240	6.240	6.240	6.240	6.240	6.240	6.240
	99	67h	0.295	0.010	---	---	---	---	---	---	---	---
	100	Stable	6.750	6.750	6.750	6.750	6.750	6.750	6.750	6.750	6.750	6.750
			20.781	20.718	21.379	22.340	23.475	25.923	26.122	26.317	26.320	26.320
Tc	99	2.1×10^5y	5.905	6.190	6.200	6.200	6.200	6.200	6.200	6.200	6.200	---
Ru	99	Stable	---	---	---	---	---	---	---	---	---	6.200
	101	Stable	6.050	6.050	6.050	6.050	6.050	6.050	6.050	6.050	6.050	6.050
	102	Stable	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300	5.300
	103	40d	2.096	1.618	1.247	0.751	0.371	0.012	0.004	---	---	---
	104	Stable	2.775	2.775	2.775	2.775	2.775	2.775	2.775	2.775	2.775	2.775
	106	1.0y	0.434	0.421	0.410	0.388	0.359	0.246	0.217	0.109	0.001	---
			16.655	16.164	15.782	15.264	14.855	14.383	14.346	14.234	14.126	20.325

TABLE XII
(Cont'd.)

Element	Mass No.	Half Life	0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Rh	103	Stable	1.904	2.382	2.753	3.249	3.629	3.988	3.996	4.000	4.000	4.000
Pd	105	Stable	1.026	1.026	1.026	1.026	1.026	1.026	1.026	1.026	1.026	1.026
	106	Stable	0.036	0.049	0.060	0.082	0.111	0.224	0.253	0.361	0.469	0.470
	107	5×10^6y	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280	---
	108	Stable	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163
	110	Stable	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079
			1.584	1.597	1.608	1.630	1.659	1.772	1.801	1.909	2.017	1.738
Ag	107	Stable	---	---	---	---	---	---	---	---	---	0.280
	109	Stable	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087
	111	7.5d	0.008	0.002	0.001	---	---	---	---	---	---	0
			0.095	0.089	0.088	0.087	0.087	0.087	0.087	0.087	0.087	0.367
Cd	111	Stable	0.059	0.065	0.066	0.067	0.067	0.067	0.067	0.067	0.067	0.067
	112	Stable	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
	113	Stable	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
	114	Stable	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
	115	43d	0.005	0.004	0.003	0.002	0.001	---	---	---	---	---
	116	Stable	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
			0.238	0.243	0.243	0.243	0.242	0.241	0.241	0.241	0.241	0.241
In	115	Stable	0.040	0.041	0.042	0.043	0.044	0.045	0.045	0.045	0.045	0.045
Sn	117	Stable	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
	118	Stable	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
	119	Stable	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	120	Stable	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	122	Stable	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
	123	135d	0.029	0.027	0.025	0.021	0.017	0.006	0.005	0.001	---	---
	124	Stable	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
	125	9.4d	0.020	0.007	0.002	---	---	---	---	---	---	---
			0.382	0.367	0.360	0.354	0.350	0.339	0.338	0.334	0.333	0.333
Sb	121	Stable	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
	123	Stable	0.024	0.026	0.028	0.032	0.036	0.047	0.048	0.052	0.053	0.053
	125	2.7y	0.103	0.116	0.121	0.118	0.114	0.100	0.095	0.074	0.009	---
	126	28d	0.075	0.052	0.036	0.017	0.006	---	---	---	---	---
	127	93h	0.017	0.001	---	---	---	---	---	---	---	---
			0.274	0.250	0.240	0.222	0.211	0.202	0.198	0.181	0.117	0.108
Te	125	Stable	---	---	---	0.005	0.009	0.023	0.028	0.049	0.114	0.123
	126	Stable	0.105	0.128	0.144	0.163	0.174	0.180	0.180	0.180	0.180	0.180
	127	115d	0.022	0.022	0.020	0.017	0.013	0.004	0.003	---	---	---
	128	Stable	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430
	130	Stable	1.525	1.525	1.525	1.525	1.525	1.525	1.525	1.525	1.525	1.525
			2.082	2.105	2.119	2.140	2.151	2.162	2.166	2.184	2.249	2.258
I	127	Stable	0.221	0.237	0.240	0.243	0.247	0.256	0.257	0.260	0.260	0.260
	129	1.7×10^7y	0.790	0.790	0.790	0.790	0.790	0.790	0.790	0.790	0.790	---
	131	8d	0.422	0.116	0.031	0.003	---	---	---	---	---	---
			1.433	1.143	1.061	1.036	1.037	1.046	1.047	1.050	1.050	0.260
Xe	129	Stable	---	---	---	---	---	---	---	---	---	0.790
	131	Stable	2.688	2.994	3.079	3.107	3.110	3.110	3.110	3.110	3.110	3.110
	132	Stable	4.450	4.450	4.450	4.450	4.450	4.450	4.450	4.450	4.450	4.450
	133	5.3d	0.696	0.097	0.015	---	---	---	---	---	---	---
	134	Stable	7.810	7.810	7.810	7.810	7.810	7.810	7.810	7.810	7.810	7.810
	136	Stable	6.420	6.420	6.420	6.420	6.420	6.420	6.420	6.420	6.420	6.420
			22.064	21.771	21.774	21.787	21.790	21.790	21.790	21.790	21.790	22.580
Cs	133	Stable	5.924	6.523	6.605	6.620	6.620	6.620	6.620	6.620	6.620	6.620
	135	3×10^6y	6.560	6.560	6.560	6.560	6.560	6.560	6.560	6.560	6.560	---
	137	37y	6.190	6.190	6.190	6.178	6.157	6.103	6.080	5.954	5.132	---
			18.674	19.273	19.355	19.358	19.337	19.283	19.260	19.134	18.312	6.620

TABLE XII
(Cont'd.)

Element	Mass No.	Half Life	0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Ba	135	Stable	---	---	---	---	---	---	---	---	---	6.560
	137	Stable	---	---	---	0.012	0.033	0.087	0.110	0.236	1.058	6.190
	138	Stable	6.120	6.120	6.120	6.120	6.120	6.120	6.120	6.120	6.120	6.120
	140	12.8d	1.253	0.555	0.247	0.049	0.006	---	---	---	---	---
			7.373	6.675	6.367	6.181	6.159	6.207	6.230	6.356	7.178	18.870
La	139	Stable	6.250	6.250	6.250	6.250	6.250	6.250	6.250	6.250	6.250	6.250
	140	40h	0.165	0.085	0.037	0.007	---	---	---	---	---	---
			6.415	6.335	6.287	6.257	6.250	6.250	6.250	6.250	6.250	6.250
Ce	140	Stable	4.382	5.160	5.516	5.744	5.794	5.800	5.800	5.800	5.800	5.800
	141	32d	2.461	1.800	1.314	0.699	0.300	0.005	---	---	---	---
	142	Stable	5.190	5.190	5.190	5.190	5.190	5.190	5.190	5.190	5.190	5.190
	143	33h	0.122	---	---	---	---	---	---	---	---	---
	144	280d	4.279	4.120	3.973	3.712	3.351	2.056	1.740	0.706	---	---
			16.434	16.270	15.993	15.345	14.635	13.051	12.730	11.696	10.990	10.990
Pr	141	Stable	2.839	3.500	3.986	4.601	5.000	5.295	5.300	5.300	5.300	5.300
	143	13.5d	1.197	0.615	0.289	0.064	0.008	---	---	---	---	---
			4.036	4.115	4.275	4.665	5.008	5.295	5.300	5.300	5.300	5.300
Nd	143	Stable	3.871	4.575	4.901	5.126	5.182	5.190	5.190	5.190	5.190	5.190
	144	Stable	0.491	0.650	0.797	1.058	1.419	2.714	3.030	4.064	4.770	4.770
	145	Stable	4.320	4.320	4.320	4.320	4.320	4.320	4.320	4.320	4.320	4.320
	146	Stable	3.870	3.870	3.870	3.870	3.870	3.870	3.870	3.870	3.870	3.870
	147	11.6d	0.636	0.247	0.097	0.015	0.001	---	---	---	---	---
	148	Stable	2.280	2.280	2.280	2.280	2.280	2.280	2.280	2.280	2.280	2.280
	150	Stable	0.735	0.735	0.735	0.735	0.735	0.735	0.735	0.735	0.735	0.735
			16.203	16.677	17.000	17.404	17.807	19.109	19.425	20.459	21.165	21.165
Pm	147	2.6y	2.542	2.891	3.005	3.022	2.947	2.555	2.434	1.862	0.220	---
	149	55h	0.047	---	---	---	---	---	---	---	---	---
	151	27h	0.090	---	---	---	---	---	---	---	---	---
			2.679	2.891	3.005	3.022	2.947	2.555	2.434	1.862	0.220	---
Sm	147	Stable	0.062	0.102	0.138	0.203	0.292	0.685	0.806	1.378	3.020	3.240
	149	Stable	1.138	1.185	1.185	1.185	1.185	1.185	1.185	1.185	1.185	1.185
	151	73y	0.375	0.465	0.465	0.464	0.463	0.462	0.460	0.457	0.424	---
	152	Stable	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282
	154	Stable	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067
			1.924	2.101	2.137	2.201	2.289	2.681	2.800	3.369	4.978	4.774
Eu	151	Stable	---	---	---	0.001	0.002	0.003	0.005	0.008	0.041	0.465
	153	Stable	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142
	155	1.7y	0.029	0.028	0.028	0.027	0.026	0.021	0.019	0.013	---	---
	156	15d	0.002	0.001	---	---	---	---	---	---	---	---
			0.173	0.171	0.170	0.170	0.170	0.166	0.166	0.163	0.183	0.607
Gd	155	Stable	---	0.001	0.001	0.002	0.003	0.008	0.010	0.016	0.029	0.029
	156	Stable	0.011	0.012	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
	157	Stable	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
			0.018	0.020	0.021	0.022	0.023	0.028	0.030	0.036	0.049	0.049
Se	77	Stable	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
	78	Stable	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
	79	6.5×10^4y	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	---
	80	Stable	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
	82	Stable	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
			0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.354
Br	79	Stable	---	---	---	---	---	---	---	---	---	0.042
	81	Stable	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133
			0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.175

TABLE XIII

Fission Product Spectrum From Fast Fission (ca. 1 Mev Neutrons) of U^{235}

(85 Days Pile Irradiation)

Element	Atoms/(100 atoms U^{235} fissioned) after cooling:									
	0 Days	15 Days	30 Days	60 Days	100 Days	300 Days	1 Year	2 Years	10 Years	∞
Se	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.354
Br	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.175
Kr	3.793	3.793	3.786	3.779	3.769	3.724	3.710	3.623	3.198	2.651
Rb	2.890	2.890	2.897	2.904	2.914	2.959	2.973	3.060	3.485	1.142
Sr	10.444	9.960	9.588	9.024	8.545	7.836	7.787	7.613	6.633	6.390
Y	3.923	4.035	4.084	4.175	4.228	4.210	4.200	4.185	4.185	4.185
Zr	30.669	20.397	20.163	29.749	29.356	28.726	28.693	28.792	29.772	27.480
Nb	1.388	1.610	1.696	1.622	1.306	0.215	0.108	0.003	---	5.425
Mo	20.781	20.918	21.379	22.340	23.475	25.923	26.122	26.317	26.320	26.320
Tc	5.905	6.190	6.200	6.200	6.200	6.200	6.200	6.200	6.200	---
Ru	16.655	16.164	15.782	15.264	14.855	14.383	14.346	14.234	14.126	20.325
Rh	1.904	2.382	2.753	3.249	3.629	3.988	3.996	4.000	4.000	4.000
Pd	1.584	1.597	1.608	1.630	1.659	1.772	1.801	1.909	2.017	1.738
Ag	0.095	0.089	0.088	0.087	0.087	0.087	0.087	0.087	0.087	0.367
Cd	0.238	0.243	0.243	0.243	0.242	0.241	0.241	0.241	0.241	0.241
In	0.040	0.041	0.042	0.043	0.044	0.045	0.045	0.045	0.045	0.045
Sn	0.382	0.367	0.260	0.354	0.350	0.339	0.338	0.334	0.333	0.333
Sb	0.274	0.250	0.240	0.222	0.211	0.202	0.198	0.181	0.117	0.108
Te	2.082	2.105	2.119	2.140	2.151	2.162	2.166	2.184	2.249	2.258
I	1.433	1.143	1.061	1.036	1,037	1.046	1.047	1.050	1.050	1.260
Xe	22.064	21.771	21.774	21.787	21.790	21.790	21.790	21.790	21.790	22.580
Cs	18.674	19.273	19.355	19.358	19.337	19.283	19.260	19.134	18.312	6.620
Ba	7.373	6.675	6.367	6.181	6.159	6.207	6.230	6.356	7.178	18.870
La	6.415	6.335	6.387	6.357	6.250	6.250	6.250	6.250	6.250	6.250
Ce	16.434	16.270	15.993	15.345	14.635	13.051	12.730	11.696	10.990	10.990
Pr	4.036	4.115	4.275	4.665	5.008	5.295	5.300	5.300	5.300	5.300
Nd	16.203	16.677	17.000	17.404	17.807	19.109	19.425	20.459	21.165	21.165
Pm	2.679	2.891	3.005	3.022	2.947	2.555	2.434	1.862	0.220	---
Sm	1.924	2.101	2.137	2.201	2.289	2.681	2.800	3.369	4.978	4.774
Eu	0.173	0.171	0.170	0.170	0.170	0.166	0.166	0.163	0.183	0.607
Gd	0.018	0.020	0.021	0.022	0.023	0.028	0.030	0.036	0.049	0.049
	201.002	201.002	201.002	201.002	201.002	201.002	201.002	201.002	201.002	201.002

TABLE XIV

Fission Product Spectrum of EBR-II Discharged Fuel
(10% Pu^{239} 20% U^{235}, 70% U^{238}) Irradiated
85 Days and Cooled 15 Days

Element	Atomic Yield from Fission Per Cent	Grams per 100 Gram Atoms Fissioned	Weight Per Cent of Total Fission Products	Weight Per Cent in Uranium Slug
Se	0.264	32.1	0.14	0.0031
Br	0.088	10.8	0.05	0.0011
Kr	2.915	247.6	1.05	0.0231
Rb	2.197	190.6	0.80	0.0176
Sr	8.128	724.3	3.06	0.0674
Y	3.333	299.8	1.27	0.0280
Zr	27,296	2558.9	10.79	0.2376
Nb	1.490	141.6	0.60	0.0132
Mo	19.500	1913.3	8.08	0.1779
Tc	6.091	603.0	2.55	0.0562
Ru	19.926	2045.1	8.63	0.1900
Rh	2.865	295.0	1.25	0.0275
Pd	5.868	625.3	2.64	0.0581
Ag	0.631	68.8	0.29	0.0064
Cd	0.486	56.9	0.24	0.0053
In	0.056	4.2	0.02	0.0004
Sn	0.343	41.7	0.18	0.0040
Sb	0.314	38.8	0.16	0.0035
Te	2.882	339.3	1.43	0.0315
I	1.611	207.4	0.88	0.0194
Xe	22.344	2985.6	12.60	0.2774
Cs	18.908	2552.2	10.77	0.2372
Ba	6.476	894.7	3.78	0.0832
La	6.014	836.0	3.53	0.0777
Ce	15.395	2182.1	9.21	0.2028
Pr	3.972	561.3	2.37	0.0522
Nd	16.099	2340.4	9.88	0.2176
Pm	2.686	394.8	1.67	0.0368
Sm	2.894	434.7	1.83	0.0403
Eu	0.335	51.3	0.22	0.0048
Gd	0.046	7.3	0.03	0.0007
U + Pu	--	--	--	97.7980
	201.453	23,684.9	100.00	100.0000

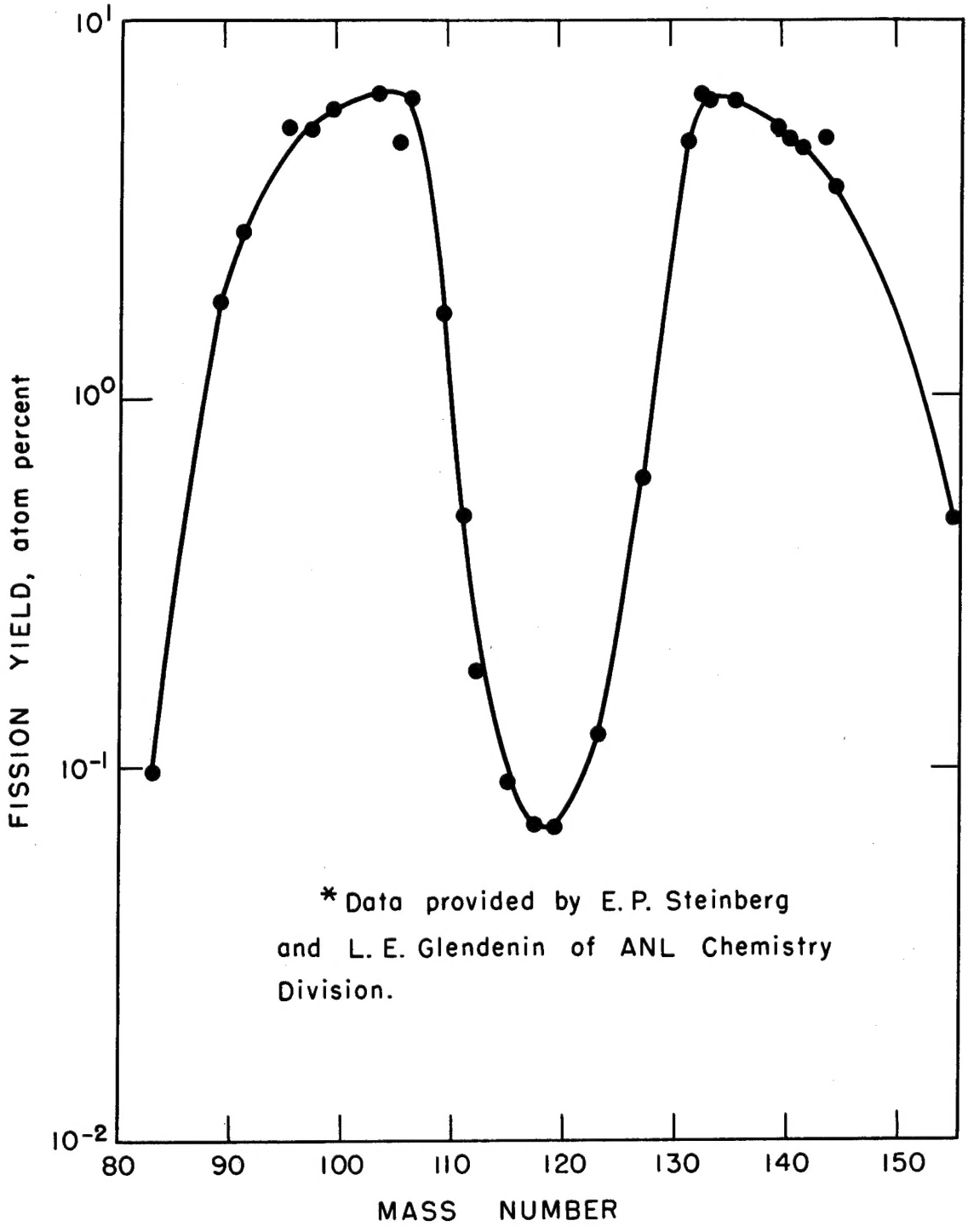

FIGURE 1.

FISSION YIELD versus MASS NUMBER
FOR FISSION OF PLUTONIUM-239
BY 2 Mev NEUTRONS.*

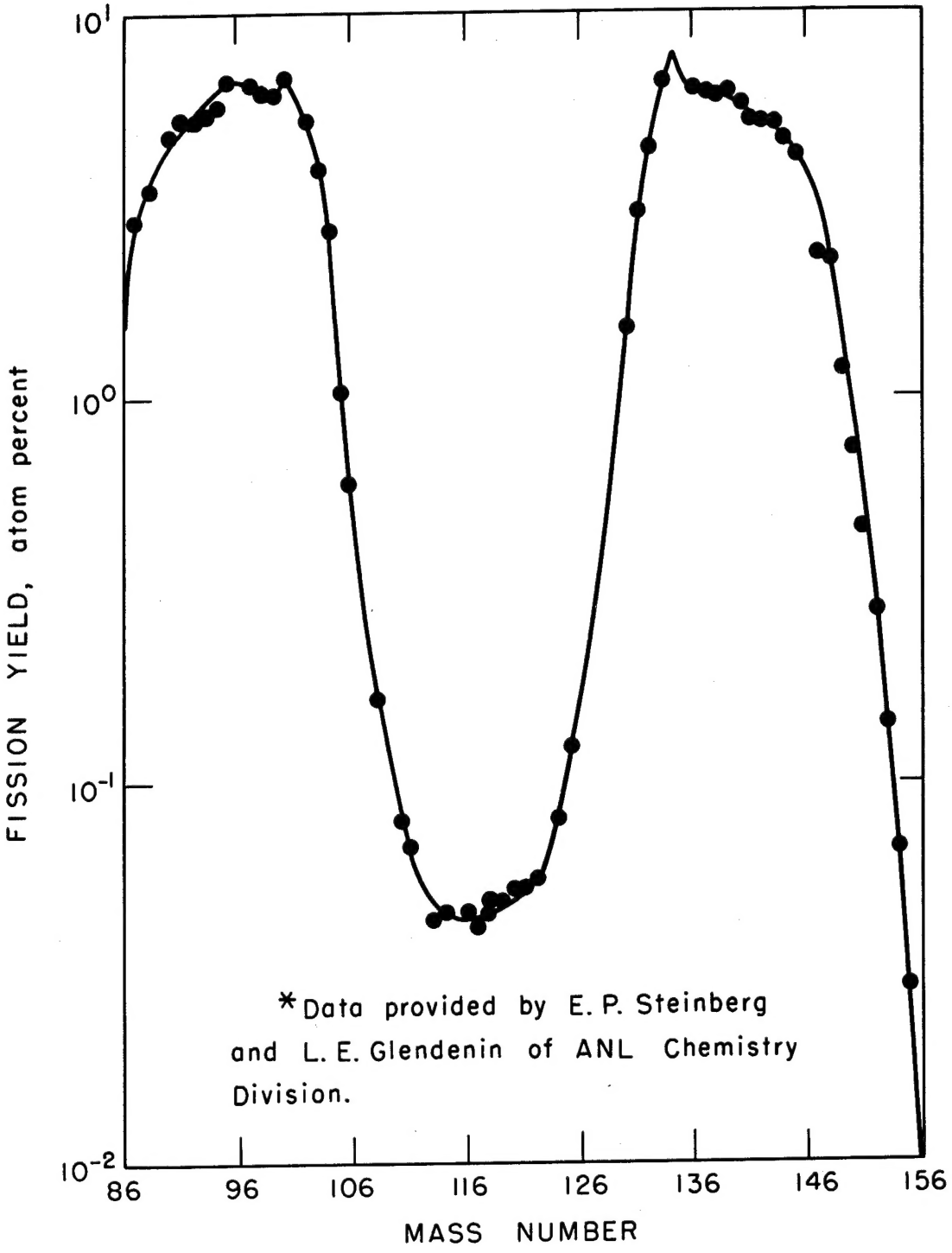

FIGURE 2.

FISSION YIELD versus MASS NUMBER FOR FISSION OF URANIUM-235 BY 1 Mev NEUTRONS.*

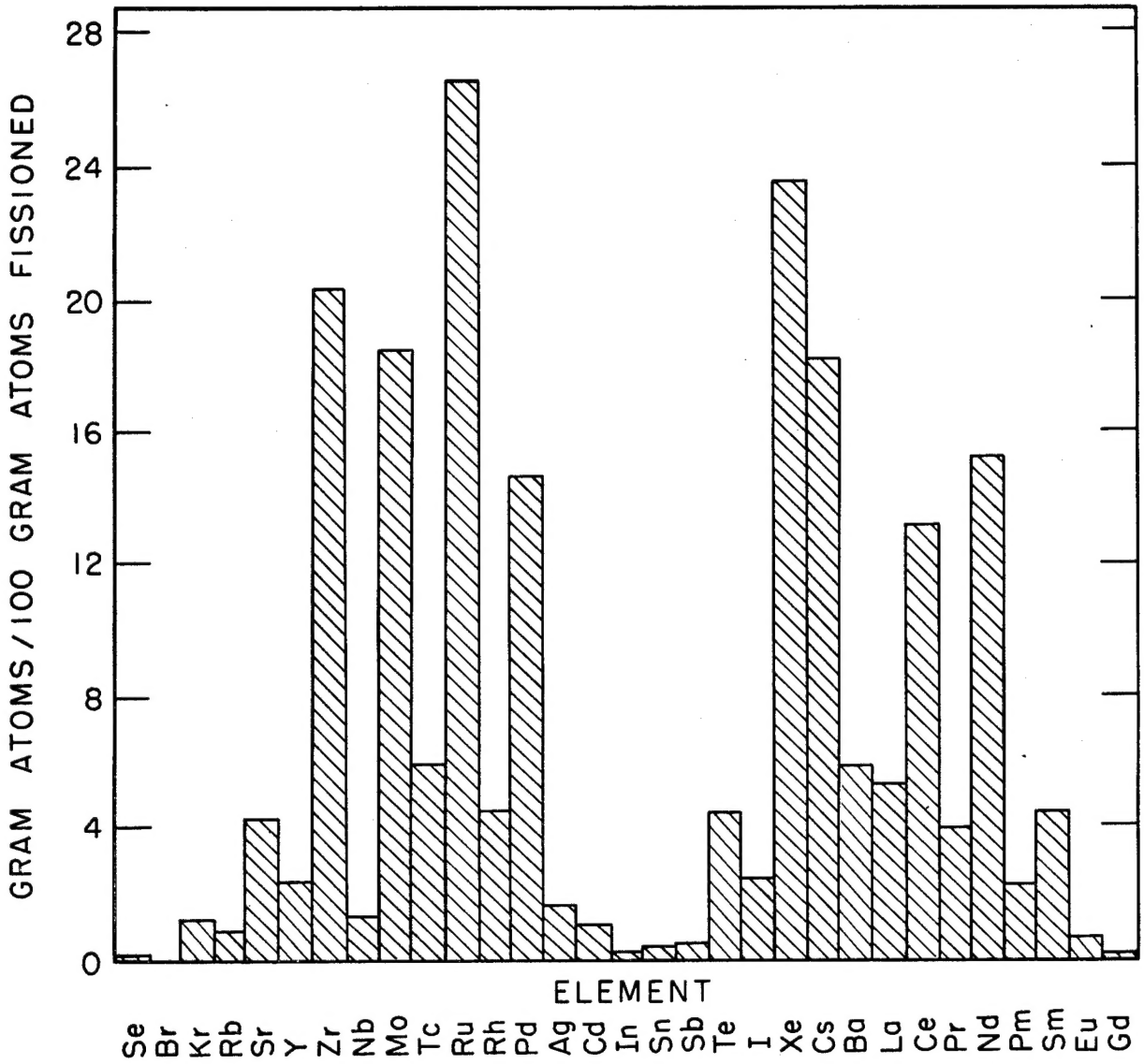

FIGURE 3.

FISSION PRODUCT SPECTRUM

PBR DISCHARGED FUEL.

Fuel 10% Plutonium-239

90% Uranium-238

(135 Days Irradiated, 15 Days Cooled)

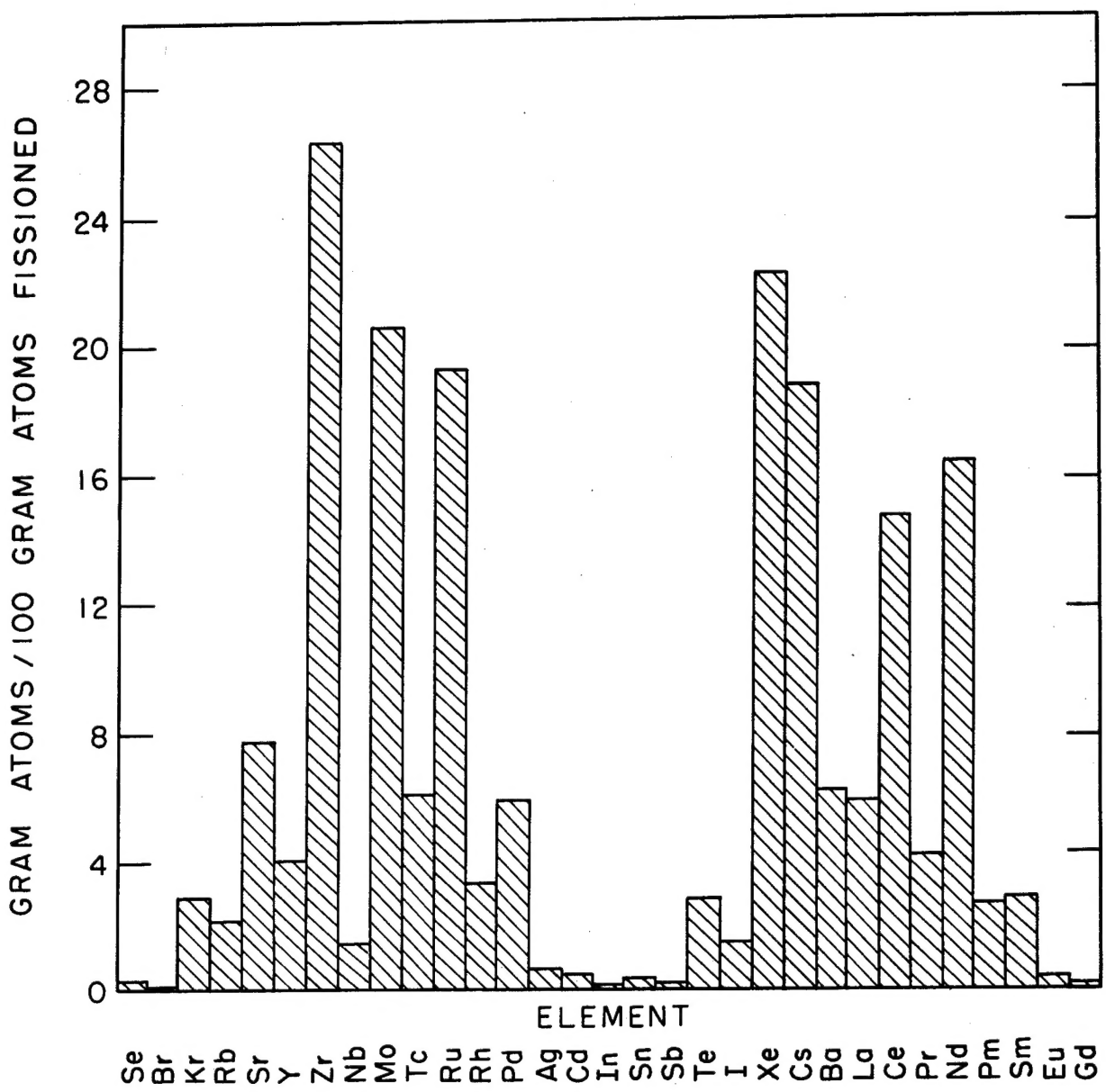

FIGURE 4.

FISSION PRODUCT SPECTRUM
EBR-II DISCHARGED FUEL.
Fuel 10% Plutonium-239
20% Uranium-235
70% Uranium-238
(135 Days Irradiated, 15 Days Cooled)